A SURVEY OF PERSEVERATION AND PERSEVERATION TESTS.

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CHAPTER I. SURVEY OF LITERATURE.

i. Muller and Psychologists directly influenced by him.

The term perseveration was first used by psychiatrists towards the end of the nineteenth century to denote the repetition, in unsuitable circumstances, by mental patients of activities previously performed. It was adopted by G.E. Muller,[27] who wrote in 1900, as a name for the supposed cause of certain phenomena he found in a series of memory experiments. In certain of his subjects in these experiments, the nonsense syllables used forced themselves into consciousness against the will in the interval between the learning of a series and the testing of it. Also in reproducing a series a subject would sometimes utter in the wrong place a syllable he had uttered shortly before in the correct one; sometimes a syllable would persist all day or even longer, being uttered whenever the subject did not know the right one. He notes that other psychologists had found the same phenomenon and that similar occurrences take place in everyday life. An investigator who has been observing something closely may find an image of it appear suddenly when his attention is not otherwise occupied. A tune may run in the mind. A chess player may repeat several times in imagination before going to sleep a game which he has played with great interest. Muller unfortunately does not say clearly whether he regards all/

all these examples as cases of spontaneous imagery recurring apart from the individual's will; in the case of the chess player the phenomenon sounds more like the deliberate working over of an interesting idea. He puts forward the view that "every presentation possesses after its entrance into consciousness a tendency to perseveration, that is, a tendency that in general weakens quickly, to rise freely into consciousness." As a result of frequent repetition a presentation may enter consciousness in this way whenever the attention is not strongly directed to anything else. He thinks, though he does not prove, that the perseverative tendency is greater when the presentation in question is interesting or has been closely attended to. He differs from Aschaffenburg, who found similar phenomena in a learning experiment, in that he does not think that the frequency, with which errors, apparently due to the perseverative tendency, occur in such an experiment, gives any sure indication of the strength of the tendency in a subject. Here he shows praiseworthy caution. He points out that such errors occur more readily when the subject is not attending closely to the experiment. They never occurred in his own case though he has a great amount of spontaneous imagery. He thinks that the result of a learning experiment is due both to the strength of the perseverative tendency of the syllables/

syllables and to the strength of their association with one another; the strength of the associations alone will not explain the result, because wrong syllables which occurred shortly before are given more frequently, when the series is tested soon after learning, than when it is tested after a longer interval, though the total number both of correct and of erroneous responses is the same in both cases. Also subjects, who did not find syllables recurring spontaneously between learning a series and reproducing it, reproduced it just as well as others who did. He notes the extremely interesting fact that there was the greatest amount of spontaneous recurrence of syllables on the first day of the experiment. He then gives an account of various differences between himself, in whom the perseverative tendency is strong, and his wife, in whom it is weak. He says that she has a better memory for what depends on association, as for learning a language by speaking it without studying the grammar, or for remembering the way to a place, but he is better at remembering small commissions not associated with any particular circumstance. He finds great difficulty in leaving off work quickly, and is able to work in the midst of distraction. He has spontaneous imagery while falling asleep or waking, as his brother does also; in his case, but not in his brother's, it is closely connected/

connected with the events of the previous day, and he thinks that this is due to the strength of his perseverative tendency. He finally discusses the value of the perseverative tendency, saying that it is not merely a useless addition to our mental processes, but serves to prevent us from losing our purposes when temporarily distracted. Individuals, however, in whom it is strong, will not be good at work that demands frequent and rapid shifting of attention.

Muller's work is interesting but few of the later studies of perseveration are closely related to it. Gross[15] perhaps takes a somewhat similar point of view in his book on secondary function. He regards association as insufficient to explain mental processes, because a train of thought is directed by the first presentation in it. He thinks that the nervous excitation, which directs the presence of a mental content in consciousness, continues after it has left consciousness in the form of an after-function, which has no conscious correlate, but which influences the choice and order of subsequent presentations. He called this secondary function, and the activity of the nervous element, while the mental content corresponding to it is still in consciousness, primary function. Those in whom secondary function is strong have a few deep narrow interests, and tend to withdraw from social contacts because of inability to/

to react quickly. Those in whom primary function is strong have broad, shallow interests, and are quick, adaptable and sociable. When both primary and secondary function are weak, exhaustion occurs; this only takes place under unusual conditions; generally the strengthening of the one means a weakening of the other. He regards mania and moral insanity as due to excessively strong primary function, and melancholia and paranoia as due to excessively strong secondary function. He thinks that the repetition of activities by mental patients takes place because there is too little primary function to make a new action possible. While he says that affect increases secondary function, he unfortunately never makes clear whether the emotional over-valuation of ideas on the part of melancholiacs and paranoiacs is, in his view, the entire cause of their strong secondary function or not. The general impression made by his work suggests that he regards the strength of secondary or primary function as the cause of mental disorder and of temperamental differences, not simply as an aspect of a state caused by emotion. Much of his attitude to insanity is of course out of date since the advent of psychoanalysis, but attempts to connect melancholia and introversion with strong perseveration, have been made within the last decade by Wynn Jones[22, 23] and Pinard[30].

Foster,[13] in 1914, attempted to test the truth of Muller's/

Muller's findings by a series of experiments. In one, the subject had nonsense syllables read aloud to him, after instructions, to give equal and best attention to each, but not to try to memorise them. He then had to lie for a minute and think of sleep, or of his bodily sensations, and after that, was asked to give whatever nonsense syllables came into his mind. From about a quarter to a half of the syllables given in this way, by different subjects, were syllables which had been read aloud, or were similar to those which had. The remainder were uninfluenced by the reading aloud, but showed a strong tendency to begin with certain consonants, which fact Foster attributes, with a fair degree of probability, to the association of certain motor impulses, with the general situation of trying to think of nonsense syllables. It is difficult to evaluate the relation of this experiment to Muller's work. A deliberate attempt to think of nonsense syllables, even although they be the first that come to mind, constitutes a different situation, from one in which syllables recur spontaneously, when the mind is on other matters. To think deliberately even of one's bodily sensations, immediately after the reading of the syllables, might cause retroactive inhibition. Neither is the number of influenced syllables, given in Foster's experiment, comparable with the number of errors, apparently due to the perseverative/

perseverative tendency, in Muller's experiments. Foster's other three experiments were learning experiments of different kinds. His main results were, that errors of the type, attributed by Muller to perseveration, did occur, and occurred more frequently if the series was tested soon, and that none of his subjects found the syllables coming to mind, between one experiment and the next, except in connection with thoughts of the experiment. With regard to the last fact, as only eight subjects took part in the experiment, it is quite possible that none of them was an individual, in whom the tendency to the spontaneous recurrence of imagery was strong. The first two facts Foster attributes to secondary associations, and not to perseveration, but he does not prove his case. He thinks that mental events observed in daily life, which seem due to perseveration, are caused either by secondary associations, or by strong impressional tendencies, but again he offers no conclusive proof. He adduces the fact, that we may awaken from a vivid dream and be unable to remember it, but that an associated idea may bring it to mind, but this does not show, that the perseverative tendency does not exist; it only perhaps shows that, for some reason, it is not strongly~~,~~ operative in this case.

In his "Text-book of Experimental Psychology", published in 1923, Titchener[43] gives an account of perseveration/

perseveration, in a way which shows that his concept of it is derived from Muller. He says that some psychologists have been led, by the phenomenon of the spontaneous appearance of imagery, to conclude that the brain is the seat of perseverative tendencies. If this is so, there are three distinct kinds of nervous tendency, the impressional tendency, which is the readiness of an idea to emerge, or the distance below the conscious limen at which its excitatory process is now going on, the associative tendency, which is the degree of excitation that will accrue to one impression when another is excited, and the perseverative tendency, which is a sort of rhythm imposed on the impressional tendency, such that an idea does now and again occur without the aid of associative tendencies. He is inclined, however, to think, that the spontaneous recurrence of ideas can be accounted for in terms of the impressional and associative tendencies alone. He argues that ideas recur spontaneously most often, either shortly after the original impression, or when the individual is tired; in the former case both the impressional and the associative tendency will be strong, and in the latter the oldest, and therefore strongest, associations will tend to operate alone. He fails to show why, in some of Muller's subjects, there was the greatest amount of spontaneous recurrence on the first day of the experiment. The experience of the nonsense/

nonsense syllables was no more recent then than on any other day, nor can the subjects have been more tired.

ii. The main stream of investigation; attempts to test perseveration.

The bulk of the work on perseveration has not been concerned with the detailed study of those thought processes and memory processes, which might be supposed to be influenced by the perseverative tendency, but with the hypothesis, that the perseverative tendency is an important factor in the determination of temperament, and with the attempt to measure its strength by various tests. In 1906, Wiersma[17] attempted to test Gross's hypothesis that different types of mental disease are associated with excessively strong primary or secondary function. His subjects were thirty-two mental patients and eleven normal people. He tested the extent to which they kept to one subject in a free association experiment, but with no satisfactory results. He also measured the length of time, for which their ability, to see a light of threshold intensity in a dark room, was inhibited by the after-effect of a bright light, the length of time, for which their ability, to feel a weak electric shock on one hand, was inhibited by the after-effect of/

of a strong shock applied to the other, and the threshold for the disappearance of flicker, when two colours were rotated on a colour-wheel. He repeated his experiments a large number of times, and found a pronounced connection between, on the one hand, a low threshold and a long duration of the inhibition and depressed states, and, on the other, a high threshold and a short duration of the inhibition and excited states. It was excitement and depression, that were discriminated in this way, and not melancholia and mania, for cases of melancholia, who were in an anxiety state, had a high threshold and a short inhibition. Both were moderate in normal people. When the patient's state changed, the height of the threshold and the duration of the inhibition changed with it; this shows, that it was emotional mood and not temperament that was being measured. One patient, for example, was admitted in a very depressed and inhibited condition on April 13th 1905; after May 13th, this yielded to an exalted state, which in turn diminished, so that she was discharged as cured on May 25th. Her threshold for flicker was 7.5 rotations per second on April 18th, 19th and 20th, 20.9 rotations per second on May 21st, 19.2 on May 22nd, 20.8 on May 23rd and 16.4 on May 25th.

Wiersma and Heymans[18] also investigated temperament/

temperature by means of a questionnaire sent to a large number of doctors, who were asked to fill it up with regard to the members of one family known to them. Temperament was regarded in this investigation as due to three variables, secondary function, emotionality and activity, but this was assumed rather than proved. They assumed the same three variables in a study of the characters of famous men[19].

In 1912-13, Webb[48] made an extensive investigation into character and intelligence. His subjects were one hundred and forty school-boys in four different schools, and two groups of men students, numbering ninety-six and ninety-eight respectively, at a training college. They were each estimated by two independent judges for a large number of intellectual and moral qualities, and were also given intelligence tests of a number of different types. In addition to the factor of "general intelligence", the tests, and the estimates of intellectual qualities, seemed to reveal a subdivision of intelligence into "quickness" and "profoundness". Each of these tended to correlate positively with one group of the qualities of character, and negatively with another; the intellectual qualities revealing "profoundness" had high correlations - several over .7 - with a group of moral qualities, of which the most important were: "Tendency not to abandon tasks from mere changeability", "Degree in which/

which he works with a distant object in view", "Perseverance in the face of obstacles", "Kindness on principle", "Trustworthiness" and "Conscientiousness", and, for the most part, negative correlations with a group of qualities including: "Quick oscillation between cheerfulness and depression", "Readiness to become angry", "Eagerness for admiration" and "Fondness for large social gatherings". Qualities revealing "Quickness" had fairly high correlations with the second group, and low, or in some cases negative, ones with the first. From this and from the intercorrelations of the character qualities Webb decided that a general factor, "will" or "perseverance", was a determinant of character, and was the cause of the difference between the two classes of intellectual qualities. He suggested that it might be connected with perseveration or secondary function, but was more inclined to connect it with a concept of will put forward by Ach.

Lankes[24], in 1914, set himself the task of investigating whether perseveration was a general factor and whether it was connected with perseverance. His subjects were forty-seven training college students, who were given a number of tests and a questionnaire. He divided the phenomena, that might be caused by perseveration, into three classes, the continuance, after the stimulation has ceased, of the physiological or psychical impression made by sensory stimulation.

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the spontaneous recurrence to consciousness of an experience, without fresh stimulation, after it has been out of the mind, and the continuance, subconscious or unconscious, of the effect of a past experience. He tested the first by an experiment on the threshold for flicker, and by a question whether the subjects felt the motion of the train or ship after a long journey or voyage. The second was tested by questions on the spontaneous recurrence of imagery and thoughts, and on the content of dreams, and by an association experiment, which was intended to find to what extent the subject repeated the same response to the same stimulus word, when it was given a second time, but which was not very successful; finally only the length of reaction time was taken as a measure of perseveration. The third was tested by questions on the ease with which the subjects could leave off work, their fondness for change, the degree to which they felt a longing for a place or occupation they had left for a long time or for good, and how far they felt a shock when stepping off a moving vehicle. It was also measured by a number of tests. In one, the Letter-writing Test, the subject had first to write groups of six letters in alphabetical order, and then to write them in the reversed order. In another, after much practice in cancelling certain letters, subjects had to cancel different ones. In another, the ability of/

of subjects to reproduce two drawings exposed in rapid alternation, was compared with their ability to reproduce one exposed alone. In another, two stories were read aloud to them, and their ability, to answer questions on the second, was compared with their ability, to answer questions on the first. In a fourth, their ability, to write an essay in a very short time, was compared with their ability to write one in a longer time. Finally, their normal tapping rate was taken, and in order that the relationship between perseveration and perseverance might be investigated, they were rated for the qualities thought by Webb to be due to perseverance. The two main results of the experiment are that the correlations between the estimates and the perseveration tests are either negative or zero, and the intercorrelations of the latter mostly positive but not very high. The four highest are .51 between the Cancellation Test and the questionnaire, .50 between the Drawings Test and the average threshold for flicker for four pairs of colours in the descending series, .40 between the latter and the Cancellation Test, and .40 between the Letter Writing Test and the Narratives Test. In spite of the lowness of the correlations, however, Lankes thinks that the performances in all the perseveration tests are influenced by a common factor. He thinks that their lowness may possibly be because the measure of/

of perseveration in most of the tests is a comparison of two variables. He suggests, that the negative relation between perseverance and perseveration, may be brought about by the more conscientious individuals resisting their perseverative tendencies more. He thinks that the correlation between perseveration and persistence would be positive in a group of people who were not conscientious, negative in a group of people who were.

Much of the more recent work on perseveration has been concerned with the measurement of it by motor tests. These fall into two main classes, creative effort tests and alternation tests, a terminology recently invented by Stephenson[41]. In the former, of which the Mirror Image Test is an example, the measure of perseveration is the speed at which a subject can perform a new activity similar to a familiar one, as compared with his speed at performing the familiar one. The first part of a motor test is usually called the X part, the second and more difficult, the Y part. In the X part of the Mirror Image Test the subject writes the letters B C D E F G in the ordinary way, over and over as fast as possible, and in the Y part he writes the mirror images of them over and over as fast as possible. In an alternation test, the measure of perseveration is the speed at which the subject can perform two activities in rapid alternation, as compared/

compared with the speed at which he can repeat either continuously. An example is the Alphabet and Number Test. In the X part of this the subject has first to write abcdefg over and over as fast as possible for a period, then to write 1 2 3 4 5 6 7 over and over as fast as possible for a similar period, and in the Y part he has to write a 1 b 2 c 3 d 4 e 5 f 6 g 7 over and over as fast as possible, and his speed in this is compared with his speed in the X part. There are two principal methods of scoring tests of this kind; the difference between X and Y may be taken, or the ratio of the one to the other. The "difference method" has been used by several psychologists, but has been found to be unsatisfactory, because these subjects, who have a high speed in the X part, tend also to have a high perseveration score. Lankes used the "ratio method" for some of his tests and for others, various elaborations of it designed to increase the reliability of the tests; he used the "difference method" only for the Essay Writing Test, where he found it gave higher correlations than the "ratio method".

In 1919-21 Bernstein[2] attempted to measure the perseveration of two groups of school children, numbering sixty and seventy respectively, as part of an investigation into whether there is a speed factor, which influences the score in intelligence tests. The/

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The subjects' normal rate of tapping in the air with the fore finger was taken, and nine motor tests of perseveration were used, the Inverted S Test, the Reverse Stroke Test, the Mirror-Image Test and the I T Test, all invented by Wynn-Jones, Lankes' Letter Writing Test, and four tests invented by Bernstein himself, the Triangles Test, the Capitals Test, the Vertical Horizontal Test, and the E A Test. The Inverted S Test could be treated either as a creative effort test or as an alternation one; here it was treated as an alternation one. In the X part, the subjects wrote Ss continuously for three thirty-second periods, and reversed Ss continuously for three thirty second periods, first a period of the one being done, then a period of the other. In the Y part they wrote the two kinds alternately for three minutes. The other three of Wynn Jones's tests are creative effort tests. In the X part of the Reversed Stroke Test the subjects wrote 2 3 4 5 6 7 , and in the Y part they wrote these figures with a "reverse stroke", that is to say, they began the writing of each figure at the point at which the normal writing of it finishes. Wynn Jones has since eliminated the figures 4 and 5 from this test, on the ground that ability, to write these with a reverse stroke, is in part a measure of intelligence. The Mirror Image Test has been already described. In the X /

X part of the I T Test the subjects had to copy a passage as fast as possible, being careful to dot the i s and cross the ts ; in the Y part they had to copy it without dotting the i s and crossing the t s. The Triangles Test was similar to the Reversed S Test in form and timing, the X part consisting of the writing of series of small triangles with the apex upwards, and series with the apex downwards, and the Y part of writing the two kinds alternately. The Capitals Test and the Vertical Horizontal Test were neither creative effort nor alternation tests, but belong rather to the class called by Stephenson "direct perseveration tests", in which the measure of perseveration is the difficulty of changing from one activity to another, when neither is well habituated. In the Capitals Test, the subjects were given a passage in which some of the words were written in capital letters, some in small, and had first to copy it exactly, then to recopy it substituting small letters for capitals and vice versa. In the Vertical Horizontal Test the subjects were asked first to copy drawings consisting of vertical, horizontal and oblique lines. Then they had to recopy them, substituting vertical for horizontal lines and vice versa; this can surely be criticised as being mainly a test of/

of intelligence, and has not been used by any other investigator. The E A Test was a creative effort test, in which the subjects had first to copy a passage as it was, then to recopy it writing an a after every e. The majority of the intercorrelations between tests were low; in the group of seventy the highest are .453 between the Inverted S Test and the Mirror Image Test, .339 between the tapping rate and the Reverse Stroke Test, and .309 between the Mirror Image Test and the Reverse Stroke Test. In the group of sixty, the highest were .302 between the tapping rate and the Inverted S Test, .301 between the tapping rate and the Triangles Test, and .301 between the Mirror Image Test and the I T Test. All the rest were below .3 in both groups, and as the tests were scored by the "difference method" the suspicion arises, that even the amount of correlation, which there is between them, may be due to the subjects' speed in writing; this suspicion is increased by the fact, that several of the correlations between the tapping rate and the other tests are negative. In addition to doing the tests, the subjects were estimated by their teachers, as to the speed with which they settled down to a new task. Two estimates were obtained, and their intercorrelation was .48 for the group of seventy, and .52 for the group of sixty. Taking the two groups together, three of the correlations/

correlations between the tests and the estimate were over .4 but under .5 and seven were between .3 and .4. This suggests that the tests may after all have been measuring, to some extent, some such factor as perseveration or initial adaptability.

In 1927 Hargreaves[16] published an account of an investigation into whether there is a group factor of "imagination", separate from intelligence. His subjects were one hundred and fifty-one children to whom he gave a series of intelligence tests, and a series of tests of imagination, of which the completion of a very incomplete story and picture are examples. He presently began to suspect that speed and perseveration were influencing the results, so he gave tests of the children's speed in writing words, figures and a continuous passage, and six perseveration tests. Two of these were new; in one, the children had to think of as many towns and villages, beginning with a certain letter, as they would, in a given time, and in the second, they had to make as many words as possible out of a given word. The expectation was that perseverators would be slower. The other tests were the normal tapping rate, the Reverse Stroke Test, the Inverted S Test and the I T Test. The first two of these six tests had some correlation with intelligence; when intelligence was eliminated, the first three had low positive correlations with speed/

speed, and the last three low negative ones. He concludes that only the last three are really measuring perseveration. He used the difference method in scoring the last three, then arranged his subjects in rank order putting the lowest perseverators first in each of the six tests. Consequently, the meaning of his three negative correlations is, that low perseveration tends to go with low speed, which confirms the view that the difference method of scoring is undesirable. All his correlations are, however, very low.

Wynn Jones[39] began before the war, and completed later, a piece of research, in which he gave the Inverted S Test, the Reverse Stroke Test, the Mirror Image Test and the I T Test, to seventy-seven children of about twelve years old. The intercorrelations ranged from .560 between the S Test and the I T Test, to .340 between the S Test and the Mirror Drawing Test. These are high, as correlations between perseveration tests go. He applied the tetrad criterion, and found that the correlations were caused by a group factor. Lest the tests should be measuring a general motor dexterity, he gave tests of speed and accuracy in making dots in small rings, speed and accuracy in copying foreign letters of the alphabet, and dexterity with balls, but these had very small correlations with each other and with the persevera-tion/

perseveration tests.

Spearman,[39] in a chapter in "The Abilities of Man", discusses this research of Wynn Jones's and also the work of Muller, Wiersma and Heymans, Lankes, and Bernstein. He applies the tetrad criterion to Bernstein's correlations, and concludes that they are caused by a general factor. He then raises the question, in what circumstances the perseverative tendency causes the hindrance of one activity by a previous one; that it does not always do so, is shown by the fact, that perseverators do not do any worse than non-perseverators in an intelligence test, in which the items are mixed. Also Bernstein found, that perseverators do not do any worse than non-perseverators, in intelligence tests done at high speed, as compared with their performance in intelligence tests done slowly. Spearman suggests that interference occurs when the two activities are very similar, as in the Inverted S Test, and when both are extensive, as in the case of children changing from one lesson to another. Finally, he puts forward the view, that the lag in mental processes, revealed by perseveration tests, is a general factor of immense importance, which has however nothing to do with either steadfastness of purpose, or with the tendency to repeat activities. He suggests tentatively that "g" may be a measure of the quantity of mental energy, and perseveration of its/

its inertia. He thinks that, when the relation of perseveration to age, sex, character, social status, and educational and vocational success has been established, by testing large numbers of people, an advance in psychological knowledge, equal in importance to the discovery of intelligence, will have been made.

22 and 23

In 1928, Wynn Jones published an account of a series of experiments at the West Riding Mental Hospital. He repeated Wiersma's experiments on the threshold for flicker, and on the length of inhibition of perception of a weak light by the after-effect of a strong one. He also gave the I T Test, the Reverse Stroke Test, using the figures 2 3 6 7, and three tests of the same type as Hargreaves first three tests. In one of these, the subjects had to name as many nouns as possible, beginning with a certain letter, in a given time, in a second, to name as many animals as possible, and in the third, to name as many objects as possible suggested by a blot. The results are much less satisfactory than Wiersma's, but, as Wynn Jones does not give a detailed description of the individuals tested, it is impossible to tell, whether his cases of melancholia included individuals in an excited state. In the last three tests, there was a general tendency for melancholiacs to show more perseveration than normal people, and normal people more than maniacs, though the three groups/

groups were not completely differentiated; the upper quartile of each group is nearly always a little above the lower quartile of the next. In the Nouns Test the upper quartile for melancholiacs is 15, the lower quartile for normal people 13, and the lower quartile for maniacs 14½. In the I T Test, the three groups are approximately equal except that the lower quartile for melancholiacs is very high. In the Reverse Stroke Test, the normal group are distinctly the lowest perseverators. In the light experiment Wiersma's result was reversed, the cases of mania having the longest inhibition, the normal group the next longest, and the melancholiacs the shortest. These groups consisted of only eight, fifteen and five individuals respectively, but even so the result is very strange. Wynn Jones thinks it may have been caused by his experiment being somewhat different from Wiersma's, in that the weak light was somewhat above threshold intensity, and the time was taken till the subjects could discriminate its shape. In the flicker experiment, the normal group had the highest threshold, and the maniacs were slightly below the melancholiacs. For the sake of comparison the following details of Wiersma's results may be given: For cases of mania, the average threshold for flicker of each individual over a number of tests ranged from 19.5 to 35 rotations per second, for the colours and illumination used.

(Slight/

(Slight changes in the colours or illumination cause considerable change in the threshold). For normal individuals, the threshold ranged from 13.2 to 20.7 rotations per second. For melancholiacs who were not anxious, the threshold ranged from 7.5 to 9.6 rotations per second, except for an individual who was discharged as cured shortly after the experiment, and who had a threshold of 15.7 rotations. For anxious melancholiacs the threshold ranged from 9 to 26 rotations.

In 1928, Baldwin and Wellman[1] published a study of the peg-board as a means of analysing form perception and motor control in young children, and among other things, gave an account of the perseverative tendencies, shown by the children when working at peg-boards. There were four boards, the first one with round holes, the second with square ones, the third with square and round holes and the fourth with round, square and triangular ones. The child was given a number of round, square and triangular pegs from which to choose the right ones. Perseverative tendencies decreased rapidly with age; nearly all the two year olds committed some errors of a perseverative type, some of the three year olds did so, but only very few of the four-year olds did. The commonest kind of perseverative error, was the placing of all round pegs throughout; other children did this until the fourth/

fourth board, when they tried to place square pegs in the triangular holes. A few children made other kinds of perseverative errors, such as placing only square pegs. That the errors were not due to confusion of form, is shown by the fact, that the pegs used were definitely selected by the children. They seem due rather to a kind of attachment to the round pegs as more familiar, or if one may say so, as more obvious and natural. The children, who showed a great deal of perseveration with the peg- board, were not found to show an unusually great amount in their other behaviour.

A somewhat different result was obtained by Cushing[9] in 1929. She found some evidence of a general factor of perseveration in pre-school children, when the term is used in the sense of a tendency to continue an activity, when external pressure for continuance has been reduced to a minimum. Incidentally, she criticises the variety of meanings attached to the term perseveration by other psychologists. Her subjects were seventy children ranging in age from twenty-three to sixty months. Six test situations were used, namely, dropping marbles through a hole into a box, fitting a key into a lock, ringing an electric bell and working other sound-producing instruments, playing with a nest of boxes, working a toy that produced coloured sparks, and working three moving/

moving toys. In every case, the child was started on the game by the experimenter, who then became to all appearance absorbed in work of her own, and so left the child free to go on playing as long as he wished. In addition, the toys were selected so as not to suggest any definite goal. The key situation differed from the others, in that a "doctored" key was substituted for the right one, after the child had started, so that the child could never achieve success with it. It was included to find whether perseverance and perseveration were the same thing. It turned out to have rather low correlations with the other tests; they range from - .05 with the boxes situation to + .38 with the marbles situation. The mean time for which the children persisted with the key situation was by far the shortest, and the times had a significant correlation with mental age. Apart from the key situation, the correlations range from .18 between the marbles situation and the visual situation - the coloured sparks - to .61 between the auditory situation and that with the moving toys. These correlations are but little reduced by the partialling out of mental age and chronological age. When the tetrad differences were calculated, there was evidence for a general factor running through all, and for a group factor common to the marbles situation and the boxes situation. Cushing thinks, that this may be, because in/

in both these the children tended to set up a goal for themselves; they often set out to put all the marbles in the box, and they built things with the boxes, as if they were bricks. Girls on the average played decidedly longer with the boxes than did boys, and slightly longer with the marbles. Cushing wonders whether this was because these were both coloured. There were a few other minor age and sex differences; differences of home environment seemed to have no effect. A questionnaire was also answered about each child by two teachers and one of the parents; it contained questions on whether the child changed its activities readily, whether it made friends quickly, whether it showed persistence of emotion, and on many similar subjects. The average rating correlated .40 with the composite score of the tests. Cushing's tests are utterly different from most perseveration tests, because they involve the whole personality, instead of being more or less mechanical. There really seems to be some evidence for a general factor of perseveration, in Cushing's sense, in pre-school children, but it seems quite likely to have no connection with what is measured by most perseveration tests. Cushing speaks of the necessity of determining, whether the trait, which she has found in children, persists unchanged in individuals throughout life, but it would be very difficult to invent tests like hers, which/

on the spontaneous recurrence of imagery and thoughts, and on the persistence of emotions. The intercorrelations of these tests were low, and in many cases negative; the only positive correlations, higher than .3, are between the mean simple reaction time and the mean choice reaction time, and between two ways of scoring the motor interference test. Jasper then discusses the previous work on perseveration, pointing out that no investigator except Hargreaves eliminated speed and "g", and his correlations were practically zero when he had done so. Jasper however thinks, that some narrow factor of motor perseveration may exist, and may have caused the moderately high correlations obtained by Wynn Jones, and that it may, on the evidence of Bernstein's work, be connected with difficulty in settling down to a new task. Jasper also measured his subjects' degree of introversion or extraversion, by the Conklin Questionnaire, and their degree of tendency to depression, by a questionnaire of his own, and found only very small correlations between these and the tests of perseveration.

In 1931 and 1932, Stephenson[40] published three articles on a series of studies of the perseverative tendencies of mental patients. The first of the three is concerned with a detailed description of the results of the application of a series of tests to a single individual, the second with a general description of the/

the tests used and their general results when applied to a large group, and the third with further detailed description of individual results, and then with a discussion of various explanations of them. The investigation is important, because there was a fair correspondence between the test results and the patients' emotional state, and because of the very thorough discussion of the results. Five tests were used. Three, the e Test, the w Test and the z Test were motor tests, involving both the creative effort and the alternation principle. In the X part of each of these tests, the letter in question had to be written in the ordinary way, in the Y_1 part it had to be written with a reverse stroke, and in the Y_2 part in the two ways alternately. A fourth was a motor test, involving only the alternation principle; in the X part, three short vertical strokes followed by a long one had to be written, thus: ııı| ııı| , and in the Y part, first three short strokes and a long one, then two short strokes and a long one, thus: ııı|ıı|ııı|ıı| A fifth was an ideational test. The subject was given a card, on which a large number of little squares of red, yellow, blue, green and black paper were pasted. She had first to point to and name the red and yellow squares, then to point to them again, but name the red yellow and the yellow red. In the motor tests, the X part was given for three 30 second periods, and each/

each of the Y parts for one such period, the pauses between varying from a few seconds to a minute, according to the time needed for explanations. The subjects were one hundred and twenty-nine patients in the Horton Mental Hospital for women. The tests were scored by the "ratio method"; when there were two Y parts, the score was $\frac{X}{Y_1} + \frac{X}{Y_2}$. Each individual's scores for the five tests were added up, after those for the w, e and Z Tests had been doubled. The result was then converted to a point on a twenty-point scale. The reliability is indicated by the fact that, when 56 schizophrenics were re-tested some months later, no score had changed by more than two points, except where the emotional condition had also changed. The average intercorrelation of the tests was .40, and they satisfied the tetrad criterion. The degree of connection between perseveration and mental state is best indicated in tabular form as follows:

Type of Patient	Range of p-scores
Paranoiacs	1 - 3
Other delusional cases	1 - 12
Dementia praecox cases with high - p	14 - 20
Other dementia praecox cases	0 - 9
Melancholiacs	2 - 15
Melancholiacs, excluding two who were almost cured	5 - 15

Type of Patient.	Range of p-scores.
Maniacs	0 - 10
Manic-depressives tested in the excited phase	0 - 5
Manic-depressives tested in the depressed phase	3 - 17
Cases of general paralytic insanity	2 - 17
Imbecile epileptics	11 - 16
Epileptics who were also psychotic	2 - 8

There is thus a certain tendency for individuals in a depressed condition to have high scores, and for those in an excited condition to have low scores, but there are a number of exceptions. The dementia praecox cases fell, as can be seen from the table, into two well-marked groups, and the members of the group with very high perseveration were decidedly more inaccessible, than the members of the group with low perseveration. This is the most important correspondence between perseveration and mental state that was discovered in the investigation. Stephenson says that the performance of the high - p praecox cases differs from that of melancholiacs with high scores in that their X activity is good and only their Y activity poor, while in the melancholiacs both are poor. The difference may be accounted for by the fact that the latter were elderly, the former young, but it seems worth while to compare it with Snoddy's[38] finding that/

that, while most mental patients show both low adaptability and low stability in learning mirror drawing, some praecox cases show low adaptability with normal stability. Low adaptability would affect the performance in a new activity, such as writing reversed strokews, but not that of the familiar activity of writing ordinary ws, which would depend on stability.
Stephenson's third article is devoted largely to a detailed study of a praecox case with high perseveration; he shows that her score varies with her emotional condition, both from day to day and during the same test. She understood what was wanted, and appeared throughout to be trying to do her best, but while she sometimes succeeded fairly well at the Y activities, she sometimes failed completely. During periods of failure, she often uttered irrelevant words and exclamations, and sometimes wrote irrelevant letters; this suggests that the failure was due to her own highly emotional thoughts breaking in and distracting her attention. Finally, Stephenson discusses various theoretical explanations of the phenomena. He notes that difficulty in performing a new activity occurs only when it is very like an old one, and thinks that the difficulty may be caused by the subject's having the idea of the more familiar activity in mind. He suggests an explanation in terms of Pavlovian reflexology, the idea of writing, for example, a w, being the/

the stimulus, the response of writing an ordinary w , a well-established reflex, and the response of writing a reversed w , a poorly established one. He is inclined, however, to prefer Spearman's theory of general inertia, which regards the X activity as having a kind of lag or after-effect, perhaps best thought of in physiological terms. He also discusses the possibility that the results are due to an inability to depart from the X activity - a kind of lack of inhibition, a weakness of will. This gets rid of the difficulty that a physiological after-effect would not be likely to change from moment to moment, as the test results do, and fits in with the fact, that some patients reverted to the X activity, when they could not do the Y activity, but it has the disadvantage of assuming that the X activity has a high native inertia - a tendency to go on indefinitely till stopped. On the whole he still prefers Spearman's theory.

In 1932 Rangachar[31] published an account of an investigation, into whether there are differences in perseveration between Jewish boys and English ones. His groups were rather small, consisting of thirty-eight Jewish boys and thirty-five English ones, but apart from that, his investigation is valuable for the care taken to eliminate causes of error. The average age of the Jewish group was 11 years and 15 days, that of the English 11 years and 5½ months, and they were of the/

the same social status. Seven tests were given: the Inverted S Test, the Reverse Stroke Test, using the figures 2 3 4 5 6 7, the Mirror Image Test, the Triangle Test, the Capitals Test, and two new ones. In one of these,the Alphabets Test, there were two X parts consisting of the writing of abcdabcd and ABCDABCD prespectively, and one Y part consisting of the writing of aAbBcCdD. In the other, the Signatures Test, the subjects had first to copy five Signatures in their own handwriting, then in as close a copy as possible of the writing of the original. The tests were given five times on each of five days, and the results of the first day's testing were discarded. The reliability of the tests was high, the lowest reliability coefficient being .759 for the Alphabets Test for the English Group. Unfortunately Rangachar does not say precisely how this was obtained, nor how much the tests varied from one trial to the next; presumably the reliability coefficient would be obtained by correlating the average of ten of the trials with the average of the other ten, and averages can conceal a good deal of variation from trial to trial. On the other hand, it might be argued that variations from trial to trial are due to chance interferences, and the average score thus indicates the subject's true perseveration. In any case, it is an advance that an investigator should have repeated tests a large/

large number of times, and realised that the earlier trials are affected by the subjects' lack of practice. Lankes[24] gave his tests on from two to four different days, and obtained reliability coefficients by correlating the results for different days; these range from .23 for the Drawings Test to .95 for the association time; many were rather low. Bernstein[2] obtained reliability coefficients by correlating scores obtained from the first half of a test with scores obtained from the second, the subjects having marked what they did at half-time. The coefficients thus obtained were all over .6 except for the E A Test, where the reliability was low. If the main cause of lack of reliability is practice effect causing a continuous change, this would have more effect on the correlation of one whole test with another, than on that of the two halves of the same test. To return to Rangachar, he scored the tests by the "difference method", and found that the Jewish boys had on the average a higher perseveration score in every test than the English ones. The correlations between tests were low, and a few were negative; for the Jewish group two were above .4 and four above .3, and for the English group two were above .5, one above .4 and three above .3. He then tested his groups by Spearman's Group Oral Intelligence Test, and found that the correlation between intelligence and perseveration was practically zero/

zero. He then correlated the perseveration scores with the speed in the X part of the test in question, and found the correlations in many cases very high. He therefore eliminated the influence of this, by multiplying the perseveration score by a factor, derived from the formula for the correlation of sums and differences, that would make this correlation zero. When this was done, the intercorrelations of the tests all became extremely low, the only one ever .3 being between the Alphabet and the Signatures Test for the English group. The perseveration scores of the Jewish group were still higher than those of the English, but only very slightly so; it is doubtful if the difference is significant.

About the same time, Pinard[30] was giving perseveration tests to one hundred and ninety-four children, in a home for children removed from bad surroundings; he wished to confirm Lankes' findings, that extremely high and low perseveration go with a small degree of Webb's "w" factor, or with poor character. He used the Inverted S Test, the Triangle Test, the Alphabet and Number Test, and the Mirror Image Test. He gave each test ten times, and discarded the first five trials, but unfortunately he scored by the "difference method", so that the validity of his results is, like that of Bernstein's, extremely doubtful. It can, in fact, be seen from the figures which he publishes, that/

that his "perseveration" score is in a large degree a measure of speed; he gives the average perseveration score of children of each age from eight to fifteen, and also the average speed in the test, and both increase together. At the price of anticipating, it may be said that Wynn Jones reported in his paper at the British Association in 1934 that he had found the perseveration score constant throughout the elementary school, when the "ratio method" of scoring was used. Cattell[6] has recently found a decrease during childhood, and up to the age of twenty-five. Pinard found, that the children with unusually high and low perseveration scores were considered difficult and unreliable by the staff of the home; the former were described as the "real rebels", the latter as "petty, nagging and whining,and happiest in a crowd". He also gave the same tests in the same way to one hundred and forty-four patients at the Maudsley Mental Hospital. Forty-eight of these were rated for the same character qualities as the children, namely, whether they were "difficult" or "self-controlled", and "persevering" or "unreliable", and the result was the same. A significant connection was also found between high perseveration and melancholia, paranoid states and suspicion, between moderate perseveration and delusions, and between low perseveration and mania. Also an attempt was made to establish a connection between high perseveration/

perseveration and introversion; a list of characteristics of introverts was compiled, and patients, in an interview with the medical officer, answered questions as to the presence or absence of these in their own characters. No connection between perseveration and introversion was found. Lists of characteristics, that seemed to be connected with different degrees of perseveration, were drawn up on the basis of the results, but it is impossible to form any coherent picture from reading them.

In 1933, Cattell[5] published an account of an investigation into temperament, in the first part of which sixty-two men students at a training college were rated by their fellow-students for a number of temperamental qualities, and in the second part of which various tests, including tests of perseveration, were applied to them. He begins by discussing the tendency of psychologists to form theories of temperamental types, and points out the similarity of many of these. The introverted, the anal erotic, and the schizothyme types, and that in which secondary function predominates over primary, are, to mention a few, very much alike. Cattell therefore drew up a list of traits, regarded as characteristic of these types and their opposites, and added some which Webb had found to be connected with his "w" factor, and others connected by Garnett with a factor called "cleverness". After/

After the subjects had been rated, he intercorrelated the traits and concluded that they fell into four groups, one which included traits such as cheerfulness, sociability, confidence, and originality, one which included traits such as perseverence and conscientiousness, and which seemed to correspond with Webb's "w" factor, and two minor groups. Regarding the second group of traits as acquired rather than innate, he drew up a type theory on the basis of the first group, calling the temperament which possesses these qualities "surgent", and its opposite "desurgent". He refuses to identify these types with any put forward by any other psychologist, though he admits that there is some resemblance between the surgent and the extroverted type. The perseveration tests used in the second part of the investigation included the Triangles Test, the Letter-writing Test, a cancellation test, and a measurement of the subjects' forearm rhythm, and of their power to reproduce their original rhythm after a faster one. The last was adapted from Cathcart and Dawson[4], as was a test of the persistence of the colour image, which was discarded as unsatisfactory. There was also a test in which the subjects had first to give rhymes to words, then to do a free association experiment; a measure was taken of the extent to which the latter was influenced by the former. In another, subjects had to say whether words were pleasant/

pleasant or unpleasant; the first word given was markedly one or the other, and it was followed by five neutral ones, and the measure of perseveration was the degree to which the feeling-tone of the first word persisted. Another test was one in which the subjects were first given a talk, and then had to detect spelling errors in a number of rapidly exposed words, some of which were related to the talk, some not; the expectation was that perseverators would detect errors more easily in the former. In another test, the Attitudes Test, subjects had to perform tasks such as first answering a series of questions flippantly, then, immediately afterwards, seriously, and the number of times the wrong attitude was taken in the second part of the test was counted. The tests were scored by the "difference method". At first the supposition was, that in the Triangles and Alphabets Test the hindrance was caused by the immediate change from the one activity to the other, and the tests were given a second time, with the former X part turned into the Y part, and vice versa. The correlations of these second trials with the first trials of the tests were, however, negative, which showed that the hindrance was due to the change from a familiar to a less familiar activity. The inclusion of so many ideational and feeling tests is interesting, but they mostly turned out to be valueless. When those tests were/

were discarded, which had correlations regarded by Cattell as too low, there only remained the Triangles and Alphabets Test, Rhythm and Rhythm Persistence, and the Attitudes Test, and even between these the two highest correlations are .23. The correlation between a pool of these five tests and the surgent temperament was .11. Like Lankes and Pinard, Cattell found a connection between extremes of high and low perseveration and lack of qualities such as perseverance. In the hope of finding some difference in origin or quality between the poor will-power of high perseverators and that of low, the six highest and the six lowest perseverators were compared, by four student judges, the college tutor, and Cattell himself, and a list drawn up of traits which seemed to be characteristic of them. This list is extremely complex, but the general impression is that high perseverators have correct, neutral personalities, are sensitive to the feelings of others, and are deep, introspective and full of conflicting feelings. The picture is, in fact, not very unlike that of the introvert, which is surprising, after the absence of connection between perseveration and the surgent temperament. Cattell also gave his subjects a questionnaire concerned with the persistence of imagery, ideas and moods, and with qualities such as absent-mindedness. The differences between high, medium and low perseverators were slight/

slight; there was possibly some tendency for high perseverators to have more recurrence of tunes, and more persistence of a good or bad mood through the day, and to be more absent-minded. There follows a useful discussion of the pit-falls of the questionnaire method.

In 1932 and 1933, Biesheuval[3] made an investigation into temperament. He began by assuming the existence of the three variables posited by Heymans and Wiersma, and a large part of his work consisted of the study of these by means of a questionnaire. His subjects were children in various schools, and the questionnaire was answered by the teachers. Among the qualities, regarded as characteristic of secondary function, are that the child works steadily, that he retains what is previously learnt, and brings it forward in subsequent discussion, that he is calm and quiet, and that he is constant in friendship. These qualities are more allied to persistence than to perseveration. Biesheuval's most interesting result is that a large number of delinquents showed a preponderance of primary function. He also found that children, in whom secondary function predominated, had, on the average, a slightly higher threshold for flicker, than those, in whom primary function predominated. In his discussion of these results, he attempts to deal with the fundamental criticism of the/

the Heymans typology, namely, that it is difficult to be sure, that the variables are really unitary and separate. He claims to have done so, but one cannot somehow feel quite sure, that he has not put them into the situation before getting them out of it. He also gave a number of motor tests of perseveration to a group of one hundred and eighty students at Edinburgh University, in an attempt to measure secondary function objectively. His results are not very satisfactory, but his work is valuable for the detailed description of the difficulties encountered. He points out, that it is impossible to be sure that the subjects work at their maximum speed, that they do not practise mentally in the rest pauses if these are given. Practice and fatigue have effects; scoring is difficult, because subjects may write badly, so that it is difficult to know what to pass and what to fail. The tests used were the S Test, the Triangles Test and Bernstein's Alphabets Test. Like Cattell,[5] Biesheuval tried the effect of giving the tests a second time with the X and Y parts interchanged, and, like him, he obtained low negative correlations between these forms and the original tests. In the Alphabets Test, the more familiar activity was actually done better, when it followed the less familiar one. Biesheuval, however, draws a conclusion opposite to Cattell's from this, namely, that the two parts of a/

a perseveration test should be equal in difficulty. In doing so, he is making the assumption, that the perseverative tendency shows itself, in difficulty in changing immediately from one activity to another, and only in this; the difference in familiarity of the two activities is nothing to do with perseveration, but if one is more familiar than the other, or, to be more precise, if it has been practised oftener, the greater facility in it will mask the perseveration effect. Cattell's view is that the difference in facility between the two tasks is the perseveration effect. Biesheuval also tried out a cancellation test and a substitution test. The former was unsatisfactory; like Lankes he found some letter groups inherently more difficult to cancel than others. The latter he regards as worth further trial. It consists of an X part, in which the subjects substitute numbers for letters, learning the key as they work, and a Y part, in which they substitute new numbers for the same letters, again learning the key. Practice effect does not come into this, as first attempts are compared, and differences in speed of learning should be equal, or could be partialled out.

In 1933 Edwards[11] published a concise summary of the whole subject. It is closely packed with criticism. For example, he says that Spearman fails to distinguish the inertia of the system, whereby the mental energy/

energy is revealed, from the inertia of the mental energy itself, and that many perseveration tests are really only measuring the former. He thinks that perseveration has two purposes, to help co-ordinated thought, and to prevent strain on the nervous system from too rapid change.

A discussion on perseveration was held at the 1934 meeting of the British Association for the Advancement of Science[33]. Papers were read by Wynn Jones, Stephenson, Vernon and Leycester King.

The papers of Wynn Jones and Stephenson were both concerned with the fact, that the term perseveration is applied to a large number of phenomena, which may not really be connected. Wynn Jones pointed out that the term perseveration has been applied to persistence of feeling, to difficulty in changing from one task to another, to some quality thought to be present in a high degree in melancholia and absent in mania, to the spontaneous revival of imagery, to the sensory persistence measured by the height of the threshold for flicker, to what Leycester King regards as perseveration, and to whatever is measured by motor tests. The last is not important in itself, but as motor tests intercorrelate, they can be used as a point of reference in studying the other phenomena regarded as manifestations of the perseverative tendency. He then discussed the difficulties connected/

connected with motor tests; the perseveration score obtained from them may be disturbed by the subjects' speed, by their intelligence, and, in the case of mental patients and difficult children, by their lack of self-control.

Stephenson began by enumerating five concepts, to which the term perseveration has been applied. One is the speed at which ideas enter and leave consciousness; the view is taken that low perseverators have a rapid flow of ideas, high perseverators a slow one. Another is the strength and duration of the secondary function, that is, of the after-effect of an idea when it has passed out of consciousness. A third is the strength of the tendency of ideas to recur spontaneously. A fourth is Spearman's concept of general inertia, which is really a combination of the first and third; Spearman thinks that the ideas of the individual with low general inertia appear and disappear quickly, and do not revive readily. A fifth is the perseveration shown by mental patients, when they repeat activities in an apparently senseless way. Stephenson then said, that he thought there was no general p-factor; in other words, the different kinds of behaviour, regarded as due to perseveration, have not all the same cause. He pointed out that mental patients, who repeat activities, do not do so slowly. He said that the recurrence of tunes is due to deep emotional/

emotional motivation, and, as he has been psycho-analysed, his evidence on this point is valuable. He then distinguished four kinds of repetitive behaviour. Two kinds are indulged in by mental patients, stereotypy and true perseveration. The first is the repetition, as a persistent habit, of behaviour which is meaningless to the patient. Truly perseverative behaviour lasts only for a certain time and has a motive. For example, Stephenson once with difficulty persuaded a patient to write his name for him; she then went on writing it again and again for some time. Stephenson did not explain the motivation of this. A third kind of repetitive behaviour is deliberate repetition for pleasure, as when a child repeats a game. A fourth is the reproduction of traumatic experiences that happened in childhood - the Freudian repetition compulsion. Stephenson gave as an example the view that Henry VIII's conduct was determined by the unconscious desire to marry his sister.

Vernon's paper, which was entitled "Perseveration tests and the concept of levels in temperament testing", was concerned mainly with the view, that perseveration tests can never measure temperament well, because the whole personality is not involved in the performance of them. This is an important criticism. It applies to all motor and sensory tests of perseveration, but not to a test such as Cattell's AttitudesTests, nor to/

to Cushing's tests, nor to estimates and questionnaires. Vernon contrasted motor tests of perseveration, and other tests of a mechanical type, with "miniature situation tests", such as the June Downey test which consists of standing with the heels raised, which are in his view much better, in that they do involve the whole personality, but which are unfortunately apt to be affected by the individual's awareness of the purpose of the test.

Leycester King put forward a view of perseveration which is all his own. He thinks that high perseverators are individuals with a narrow complex span. The meaning of this term can be best explained, by saying that Leycester King tests the width of an individual's complex span, by finding whether he learns nonsense syllables better in small or in large groups. The individual, who learns them better in small groups, has a narrow complex span. Using a group of twenty subjects, Leycester King found a correlation of .39 between narrow complex span and high perseveration, as measured by a number of motor tests. This correlation seems large enough to render the subject of complex span worthy of further study.

In 1934, Stephenson[41] published an article in the British Journal of Educational Psychology on motor tests of perseveration. He begins by pointing out, that motor tests do correlate with each other, with sensory/

sensory tests, and with estimates of the degree, to which imagery recurs spontaneously in an individual, and that they have a non-linear relation with Webb's w- factor, as both high and low perseverators appear to be weak-willed. He mentions the criticisms, that the tests are unreliable, and the correlations between them low, and that simple motor and sensory tests cannot make contact with profound qualities of character. He then distinguishes three types of motor test, the "alternation test", the "creative effort test" and the "direct perseveration test". The first two have been already defined; the cancellation test of perseveration is an example of the last; in such a test the measure of perseveration is the degree of hindrance found, when the subject changes from the continuous performance of one activity to the continuous performance of another, both being unfamiliar. Stephenson says that the Y part of such a test is done more slowly than the X part only when it is harder, and that in that case it is done more slowly, even when it is done first. Thus such tests do not measure perseveration at all. It looks as if the correlation of .51, which Lankes obtained between such a test and his questionnaire, was caused by some other factor or factors than perseveration. Stephenson thinks that, in the first two kinds of test, there is nothing essential to the measurement of perseveration in/

in the similarity of the activities involved, but that probably tests in which the activities are similar, and which involve both the alternation and the creative effort principles, are more highly saturated with perseveration than any others. There follows a very stimulating discussion of the question of what the tests are really measuring. The theory of inertia is taken first. What is measured in sensory tests is certainly some sort of inertia of the physiological processes taking place in the sense organ concerned, but Stephenson points out, that what is measured in a motor test is much more complex. At first sight, the alternating part of a test such as the S Test, which involves both the alternation and the creative effort principle, might appear exactly analogous to the flicker test, but really two new factors have been introduced; the reversed S is new, and it is similar to the ordinary one. It is in the newness and similarity, that the difficulty of the test really lies. As in a previous article, he suggests that this type of test is hardest, when the idea of the familiar activity is in mind while the new one is being tried. He next suggests, that the correlations between perseveration tests may be due to their indirectly measuring strength of will. Weak-willed individuals will do the Y part of the tests badly, through failure to make the necessary effort, and sensitive individuals, who/

who are much afraid of failure, may do it badly from nervousness. Correlations of the sizes that have been obtained between perseveration tests might easily be caused by a few extreme cases; analysis of correlation coefficients is needed. Extremely high and low perseveration scores are more reliable than moderate ones. The correlations that have been obtained between perseveration scores and estimates of qualities of character may be similarly caused, for extremes of character are the most reliably estimated. In certain cases, however, an unusually energetic individual may appear to be a high perseverator, not because his Y activity is unusually poor, but because his X activity is unusually good; so may a child, who is older than the majority of the group being tested. In the third place, Stephenson discusses the view, which he had put forward previously, that perseveration tests measure will power directly, because inability to do the Y part of a test is due to lack of a kind of will power, which is needed to inhibit the X activity. Fourthly, he points out that something of the nature of perseveration may be a help and not a hindrance in the Y part of a test, as when the subject says that he has "got into the swing of it"; thus an individual may have a low perseveration score as a result of possessing a high degree of perseveration, in this sense of the word. Perseveration/

Perseveration in this sense may be allied to strength of will, and this may account for the fact, that individuals of good character tend to have low perseveration scores. Stephenson reminds the reader that perseveration was regarded as a valuable quality by Muller, Gross and Heymans, whereas most modern psychologists regard it as an undesirable one.

Cattell has recently published two articles on perseveration. The first[6] deals with an investigation into a number of problems connected with motor tests. One problem was whether creative effort and alternation tests are really measuring the same quality. To study this, he gave his fifty-two adult subjects one creative effort test, a reversed stroke test using the figures 2 3 4 , and three alternation tests. In one, the X_1 and X_2 parts were both unfamiliar, consisting of the writing of ∞ ∞ ∞ . . . . and ∓ ∓ ∓ . . . . respectively. In one, the Alphabets Test, both were familiar; they consisted of the writing of abcd abcd . . . and A B C D A B C D . . . respectively. In the third, the X_1 part consisted of the writing of 2 3 4 2 3 4 . . . in the ordinary way and the X_2 part of writing them with a reversed stroke; thus the X_1 activity was familiar and the X_2 activity new. This test is, of course, another form of the Reverse Stroke Test. The correlations of the Reverse Stroke (creative) Test with the three alternation tests were .32 and .45/

.45 with two forms of the $\infty \neq$ Test, that differed as to timing, .29 with the Alphabets Test, and .52 with the Reverse Stroke (alternation) Test. This last correlation is, of course, spuriously high, because, as will be proved in chapter V, when the same test is scored both as a creative effort test and as an alternation test, there is bound, for mathematical reasons, to be some correlation between the two scores. The correlation of .29 with the Alphabets Test is not statistically significant, but the correlations with the $\infty \neq$ Test are, so that unless these can be shown to be also spuriously high as a result of the findings given in Chapter V, Cattell has succeeded in proving, that alternation tests and creative effort tests are measuring the same factor or factors.

Cattell also gave an alternation test, called the Aitches Test, in which the X_1 part consists of writing H H H . . . the X_2 part of writing I I I . . , and the Y part of writing H I H I . . This was designed to have no correlation with intelligence, on the ground that H I cannot be seen as a new gestalt by the more intelligent, as, for example, S can. Its highest correlation with any of the other tests was .39 with the Alphabets Test. He also invented a machine, called a Perseverameter, for the measurement of perseveration. It consists of six keys of different resistence to pressure and different trajectory/

trajectory, in the pattern

1 3 5

2 4 6 .

X_1 consists of pressing the keys 2 3 4 5 .. in order repeatedly with the forefinger, X_2 of pressing 2 5 6 1 .. , and Y of pressing 2 3 4 5 2 5 6 1 . . The advantage of this machine over other tests is that the subject cannot sacrifice quality for the sake of speed, and that the labour of scoring is much decreased. The results of this test correlated .37 with the Reverse Stroke (creative) Test, .36 with the Alphabets Test, and . 34 with the Reverse Stroke (alternating) Test, so that it is as good a measure of perseveration as most tests. Cattell also tried to standardise the quality of performance in the other tests, by making the subjects write on paper of a standard size, setting a model before them, and giving very clear instructions which were frequently repeated. To make sure that the motor tests were measuring the same quality as sensory tests do, he gave Stephenson's Colour Naming test. Its highest correlation with any of the other tests was .19, which is hardly satisfactory. The X_1 and X_2 parts of each test were given for two fifteen-second periods, and the Y part for four fifteen-second periods. The pauses between these lasted about seven seconds. Cattell thinks, probably rightly, that the longer periods/

periods usually given are apt to cause fatigue. He scored two of the tests a second time, omitting the first period of each X part, which might be affected by warming up, and the last two periods of the Y part, in which the effect of perseveration might be diminished. These curtailed tests had slightly higher correlations with the others than the longer forms, when they had been corrected for their shortness by the Spearman-Brown formula. Cattell also gave three motor tests and the Colour Naming Test to two groups of fourteen-year old children, but the intercorrelations were low. The Alphabets Test - a form using abc only - correlated .27 with intelligence in one group. In a group of ten-year old children, Cattell found some connection between perseveration score and intelligence in the case of the Triangles Test; in the adult group there seemed to be none. By testing children of various ages, and by analysing the scores of his adult group, Cattell concluded that perseveration decreases up to the age of twenty-five, remains constant through adult life, and may rise in extreme old age. Between the ages of ten and twenty-five, boys and men are higher perseverators than women and girls; the difference is greatest about the age of fourteen. One wonders if this last fact is connected with the fact that girls reach puberty sooner than boys. Finally, in order to study the effects of practice/

practice and fatigue, Cattell gave four tests, the w Test, the Colour Naming Test, the Alphabets Test, using abc only, and the Triangles Test, to three boys of widely different temperament, at 9.30 A.M., 11.30 A.M., and 4.10 P.M. on three successive days, and on a fourth day, separated from the others by a week-end. The score increased during each day, and fell from one day to another. The number of subjects is, of course, far too few for this result to be conclusive, but supposing that it is true of most individuals, it might be explained as follows, on the assumption that the phenomena, discovered by Snoddy[38] in connection with the learning curve for mirror drawing, are also true of the learning curves of the parts of a perseveration test. The X activity, which is more familiar, is at the facilitation stage of a learning curve, and so improves the more, the oftener it is practised, while the less familiar Y activity is at the adaptation state, and so improves in the interval between one test and another. If this is so, the fall of score between one day and the next, should be greater in the w Test, which involves the unfamiliar reversed w in the Y part, than in the Alphabets Test, in which both the items which are alternated are familiar, and only the activity of alternating them is new. Probably the main value of Cattell's experiments is in the improvement in/

in timing the tests, and in the invention of the Perseverameter. The latter is important because it proves that whatever is measured in motor tests cannot be accounted for in terms of writing movements.

Cattell's second article[7], which was published in the Journal of Mental Science for January 1935, deals with the connection between perseveration scores obtained from motor tests, and temperament or character. He gave eight tests to a group of fifty-two of his relatives and friends, whose characters he knew, and drew certain conclusions, from comparing the characters of the ten highest and the ten lowest perseverators. He thinks that the main difference between them is that low perseverators tend to act when dissatisfied, while high perseverators resign themselves to the unpleasant. The ten lowest perseverators included a girl who had run away from home, a man who had divorced his wife, and a man who had been sent down from college for disobeying regulations to which he objected. Most of the other characteristics seem to form a fairly coherent picture with the principal one. Low perseverators are said to be more enterprising than high ones, more assertive and inclined to lead others, more practical and objective in thought, and better able to keep a number of alternatives before their minds in making a decision. They are more sure of themselves, do not, like the high/

high perseverators, exhaust themselves for a cause, and are fond of an audience, and loyal mainly to persons, while the high perseverators will work well alone, and are loyal to abstract principles. The picture of the low perseverator bears, in fact, a fair resemblance to that of the extrovert, which is somewhat surprising, as Cattell begins the article by saying that countless observations have convinced him, that perseveration is not connected with extroversion-introversion, nor with surgency-desurgency, which he now regards as the core of extroversion-introversion. It is impossible, however, to discuss all this, without digressing too far into the realm of the study of temperament.

Cattell also gave his subjects a questionnaire, which included questions on how strictly they were brought up, on their taste in art, on their changes of mood, on their fondness, or lack of fondness, for well-known objects, on their present and past health, and their position in the family. An interesting result is, that low perseverators say, that they were strictly brought up, but were disobedient. Cattell is well aware, that an individual's estimation of the strictness of his parents, does not necessarily correspond with the reality. One explanation, which he suggests, is that the low perseverators were more aware of parental discipline, because they were more rebellious/

rebellious. Later, after suggesting, that high perseverators are individuals with deep emotional conflicts, which seems quite possible from their general type of character, he makes the alternative suggestion, that high perseverators have been spoilt in childhood, and that this is the cause of their conflicts. The two views are not mutually exclusive, as deep conflicts may be caused by either spoiling or over-severity, and, in the latter case, it is quite possible for the individual to be unaware that his parents were over-severe, owing to the very painfulness of the subject.

Cattell also studied the relationship between perseveration and race. Both the group of relatives and friends, and a group of sixty-two students, were classified as to racial characteristics, and there is some evidence, that individuals, belonging to the Mediterranean race, tend to have higher perseveration scores, than individuals belonging to the Nordic race.

In the same number of the Journal of Mental Science, is an article on perseveration by K.H. Rogers.[35] It consists mainly of an account of previous work on the subject, but contains brief descriptions of three of Rogers' own investigations. In one of these, he gave perseveration tests to a group of subnormal children, and found that very high perseverators tended to be persistently difficult, while very low perseverators tended to have sporadic outbursts of bad/

bad behaviour. This is in accord with the findings of Pinard. In a second, he gave perseveration tests to a large group of normal school children, and found that very high and very low perseverators tended to do better at school work, in proportion to their intelligence, than moderate ones. He suggests, that this is because very high and very low perseverators have a need to compensate, by intellectual success, for defects in other directions. He also found that high perseverators tended to do well at literature and grography, low ones at reading, spelling and writing, a result for which it is difficult to suggest an explanation. In his third investigation, he gave perseveration tests, and a continuous word-association test, to a group of high-grade defectives, and found that while the highest perseverators tended to give words connected with the hospital and the testing room, the lowest perseverators tended to give more original ones. The same subjects were also estimated, as to character, by four workers, and it was found, that high perseverators tended to "depression" and "autism", and low perseverators to "instability" and "antisocial" tendencies. Rogers' findings are in general in line with Pinard's, but he does not say what tests he used, nor whether he scored them by the "difference method" or the "ratio method". The latter is a serious omission.

In/

49

In July 1935, E.P. Yule published an article in the Journal of Mental Science, entitled "The Resemblance of Twins with regard to Perseveration". After a very thoughtful discussion of the possible effects of heredity and environment on the characters of monozygotic twins, dizygotic twins of like and unlike sex, and sibs of like and unlike sex, an investigation is described, in which a number of perseveration tests was given to a group of sixty unrelated London elementary school children, aged from 9 years 5 months to 12 years 6 months, and to one hundred and fifteen pairs of twins, aged from 10 years 0 months to 13 years 11 months. The tests used were the S Test, the Triangles Test, the e Test, the Z Test, the 9 Test, the 2 Test, the 6 Test and the G Test. The last four, as well as the e and Z Tests, were invented by Stephenson. In all of them, the letter or figure in question has to be written first in the ordinary way, then with a reversed stroke, then both ways alternately. The tests were scored by the "ratio method". Split-half reliability coefficients, ranging from .403 to .666, for various groups of tests, were obtained, and test re-test reliability coefficients, ranging from .016 for the Z Test and .330 for the e Test, to .522 for the 9 Test and .523 for the 6 Test. These are not very high. It was proved that there was no connection between the perseveration score and age, sex, or intelligence as measured by the Otis Advanced (Form/

(Form A) Group Test. Monozygotic twins showed more resemblance in their perseveration scores than dizygotic twins. Dizygotic twins of like sex showed more resemblance than dizygotic twins of unlike sex, and all twins showed more resemblance than unrelated pairs of children. This result proves, that whatever is measured by perseveration tests is due in part to heredity, and not environment. It does not prove that they measure an important quality, any more than does the fact, that the correlations between motor tests of perseveration can be shown to be caused by a common factor, prove that this factor is an important temperamental quality.

iii. Literature on Allied Subjects.

Yule's article is the last contribution made to the main stream of investigation into perseveration, but certain literature dealing with allied subjects may be briefly surveyed. It may be subdivided, into literature containing no reference to any kind of persistence of behaviour, but bearing upon the performance of subjects in motor tests of perseveration, and literature dealing with various forms of persistence of behaviour.

It seems possible, that certain of the results of Snoddy's[38] study of the learning curve in mirror drawing, may bear upon the results of motor tests of perseveration/

perseveration. In Snoddy's experiments, the subject had to trace, with a metal pointer, by the aid of the mirror image only, the figure of a star cut out of brass. Errors, that is to say contacts of the pointer with the sides of the figure, were electrically recorded. The subject was carefully paced, by means of instructions as to speed and accuracy, so that his time in seconds equalled the number of errors made. After a certain amount of practice, he was encouraged to reduce his errors till he eliminated them completely. By means of this procedure, it was possible to study the learning curve very accurately. It was concluded that the learning curve falls into two parts. In the earlier, or "adaptation", part of the curve, improvement is rapid and takes place between one trial and the next. The longer the interval between two trials, the more improvement takes place. This, in Snoddy's opinion, suggests that the improvement is due to growth in the nervous system. In the later, a "facilitation", part of the curve, improvement is slower, and is the greatest when successive trials follow one another immediately. Snoddy regards this improvement as due to something of the nature of the condensation of a pattern of activity in the nervous system. Much detail is given as to the effect upon the learning curve of different time intervals. Snoddy studied the learning curves of a large number of normal children/

children and adults, of all ages, and also of mental patients. He found that adaptability improves up to the age of twenty-five, and is greater in women and girls, than in men and boys, from puberty to about twenty-five years old. In adults over twenty-five, adaptability remains constant up to extreme old age, and the sexes are equal. In extreme old age it falls. The relationship of adaptability to age and sex is thus exactly like the relationship between perseveration score, on the one hand, and age and sex on the other, which Cattell[6] found in his recent investigation. It has also been already noted, in the discussion of Stephenson's application of perseveration tests to mental patients, that Snoddy found that, while most mental patients have both low adaptability and low stability, certain cases of dementia praecox have low adaptability with normal stability.

In 1926 Robinson and Bills[34] published an article entitled "Two Factors in the Work Decrement", which is of interest, because the test material used was rather like that used in perseveration tests. They set themselves the problem whether the decrease in output, caused by fatigue, is greater in homogeneous than in heterogeneous work. In their first experiment, the subjects had to write certain letters of the alphabet over and over for twenty minutes. The most homogeneous task consisted of the writing of two letters/

letters alternately in groups of six, thus: ababab ababab . . The most heterogeneous consisted of writing abcdef abcdef . . Intermediate between these two was a task consisting of the writing of abcabc abcabc . . or def def . . It was found that not only was the decrease from fatigue least in the most heterogeneous task, but the initial efficiency was greatest. This may have some bearing on the fact that subjects sometimes do the Y part of an alternation test of perseveration faster than the X part. The difference in initial efficiency between the three tasks, in the experiment of Robinson and Bills, disappeared, however, when the letters were grouped in twos, thus: ab ab ab . . or ab cd ef . . In a second experiment, the task consisted of naming one hundred letters of the alphabet printed on a card. In the most homogeneous form, there were only two letters, arranged in random order, and in the most heterogeneous, there were twenty-four different ones. The result was essentially the same as in the previous experiment. In both experiments "blockings" occurred frequently. These momentary stoppages of the work occur also in motor tests of perseveration. In both, the subjects worked better when they thought about something else. It was found by a third experiment, in which the task consisted of the typing of one, two or three letters, that homogeneous work has the highest initial/

initial efficiency when complex, delicate movements are involved. This suggests that the factors, which determine the performance of subjects who are tested by means of Cattell's perseverameter, may be in some degree different from those which determine their performance in the usual motor tests.

Saudek's[37] chapter on "The Relative Speed of the Act of Writing" in his book entitled "Experiments with Handwriting" has some bearing on motor tests of perseveration, for writing movements are involved in these. It is unnecessary to give a full account of the contents of the chapter, as much of it is irrelevant to the present purpose, but certain facts pointed out by Saudek may be noted. The fact that the speed of the moving pen or pencil is constantly varying as writing takes place, and that it alters with every alteration of direction, suggests that, even if motor tests of perseveration really measure the perseverative tendency, they can never measure it with a high degree of accuracy owing to the influence of other, very complex, factors. The fact that it takes longer to make a dot than a short line, and that it is impossible to make a dot at all when writing at high speed, explains one of the difficulties experienced by subjects in performing the Division Signs Test. The fact that, when an angle is made, there is a relatively long pause in the writing movement, bears on various perseveration tests/

tests. It is also, perhaps, noteworthy, that long strokes are made relatively faster than short ones, that the speed is less when the pressure is heavy, and that writing, which slopes in a backhand direction, is done more slowly than that, which is upright, or which slopes in a forehand direction. There is a relatively long pause, when the pencil or pen is lifted from the paper and applied afresh; this explains why subjects sometimes begin to write the units in a perseveration test continuously instead of separately, as one subject did in the w Test in Experiment III of the present investigation.

One of the most careful studies of a phenomenon rather similar to those ascribed to the perseverative tendency is the study, made by Cathcart and Dawson,[4] of what they call "persistence". Their first experiments were made with the ergometer, a wheel worked by horizontal levers. They found that, while subjects had a natural rate of work, which remained fairly constant from day to day, yet, if they deliberately worked at a faster rate, then reproduced what they thought was their natural one, they unconsciously adopted a slightly faster "natural" rate than usual. Similarly the natural rate was slowed a little after slow work. The same phenomenon was found to occur in strength of grip, rhythm of finger and hand movements, rhythm of playing music, and memory for pitch, colour/

colour and visual size. M.D. Vernon[46] has recently found that it also occurs in connection with the perception of inclined lines. That the persistence effect is sometimes counteracted by the individual, is shown by its absence, with regard to musical rhythm, in a woman accustomed to play for dancing. She was not aware of counteracting it, but she knew she was playing good time. It is possible, though not very probable, that this phenomenon of "persistence" is connected with perseveration.

gap here

In 1923, Courbon[8] published an article, on the tendency of the very old to keep coming back to the same subject of conversation. He regards it as a milder form of the repetition of behaviour of the insane. He begins by distinguishing "rabachage", which is repetition for an ulterior motive, as in the case of an old lady, who was trying to convince herself that she was not losing her memory, from "radotage" which is repetition for its own sake. He then subdivides the latter into two kinds, according to whether the repetition is of an account of what the individual has done, or of a prevailing idea. As an example of the former, he describes an old lady, who entered a mental hospital, because of a temporary emotional disturbance, and stayed after she was cured of this, because she had no relatives. She constantly wanted to talk to the doctors about her marriage and other/

other incidents of her youth; when asked why, she replied that it was the only pleasure she had left - "tout le reste m"est egal". He gives two examples of the latter. The first is a man who was greatly concerned in defending Dreyfus. After the case he gave, or appeared to give, the subject no more thought, but in old age he began to talk constantly about the importance of finding out the truth. The second is an alcoholic old sailor who ended every conversation with the remark: "I don't care; I'm captain". From childhood he had wanted to be captain. Generalising from these three cases, Courbon connects the former type of repetition with a general decay of the cerebral cortex, the latter with local lesions preceding a stroke.

Courbon's distinctions may be unduly fine, but the stress he lays on the emotional motives for repetition makes his article almost worthy to be set beside Freud's[14] discussion of the repetition compulsion. This can be only briefly mentioned. Freud's view is that neurotics in a high degree, and normal individuals in a lesser one, tend to reproduce situations, which they are unable to master emotionally, even although to do so may land them into unpleasantness. The process is of course usually unconscious. As an example of a child working over a difficulty symbolically/

symbolically in play, he describes a baby who was very fond of throwing various small articles under a piece of furniture and shouting that they were "gone". Freud interprets this, as due to worry about his mother going away and leaving him. The psychoanalytic finding, that children do work over worries in this way, suggests, that tests such as Cushing's could never have very high reliability, as play material must have different meanings for different children. The repetition compulsion is probably an important factor in determining human conduct, but it has little connection with perseveration, as the term is usually understood.

CHAPTER II. EXPERIMENT I: PROBLEMS CONCERNED WITH THE LENGTH OF THE INDIVIDUAL UNITS IN A PRESEVERATION TEST, AND VARIOUS MINOR PROBLEMS.

i. Introduction and Statement of Problem.

The present investigation has been concerned almost entirely with problems connected with motor tests of perseveration. Two main facts seemed to emerge from a survey of the literature: the inter-correlations between motor tests, obtained by previous investigators, were small, but sometimes statistically significant, and there was some, not very well-established, evidence that the motor tests were measuring a general factor of preseveration, that played a part in the determination of temperament. It was felt that the prime need was to try to improve the tests, so that the correlations between them should be really high. If that could be done, it would be certain that some quality was being reliably measured, and it would then be possible, to go further and to try to find, whether this quality played an important part in the determination of temperament, or was identical with the cause of any of the other phenomena attributed to the perseverative tendency.

Alternation tests alone were considered in the first experiment, and Biesheuval's[3] view, that the two parts/

parts of the test should be of equal difficulty, was tentatively adopted. The "drag" in alternation tests is usually slight; the alternating part is done only a little more slowly than the other two; subjects sometimes even do it faster. It seemed possible, that the lowness of the intercorrelations between perseveration tests, was due to the smallness of the "drag". The perseverative effect, which was accustomed to be the cause of the "drag", seemed to be manifesting itself to so slight a degree, that it was constantly being masked by other factors, such as practice, fatigue, and change of mood. Hence, if tests could be devised in which the "drag" was greater, it seemed likely that the intercorrelations might be higher. The writer found that, in her own case, there was a much greater difference in speed between the X and Y parts of an alternation test, when the individual units in the X part were very short and simple. A "short" unit may be defined as one, which the majority of subjects make at the rate of about two to five per second, and a "long" one as one, which the majority of subjects make at the rate of less than two per second. All, or practically all, the units used in perseveration tests in the past, have belonged to the latter class. It may be remarked, in passing, that the present writer finds it extremely difficult, to discover test units, which she performs at/

at the rate of about eighty per half minute, when working as fast as possible. It is easy to find plenty of units, that can be done at less than sixty per half minute, and fairly easy to find units, that can be done at well over a hundred per half minute, but there seems to be a sort of gap in speed between the "short" and the "long" kinds of unit. This suggests, that some characteristic of the neuro-muscular system, that is not yet understood, is involved.

It seemed, therefore, that tests involving "short" items were likely to be better than tests involving "long" ones, and the following problems were formulated:

(1) To find whether tests involving "short" units give a higher perseveration score than tests involving "long" units.

(2) To find whether tests involving "short" units have higher intercorrelations than tests involving "long" ones.

(3) As a minor problem, to find:

(a) the effect of giving rest pauses between the parts of a test, as opposed to giving no rest pauses.

(b) the effect of shortening or lengthening the rest pause between one test and the next.

The practice of psychologists with regard to the giving of rest pauses has varied. Pinard,[30] for example, gave/

gave none, Bernstein[2] gave pauses of a few seconds, Stephenson[40] gave pauses of varying length, and Biesheuval[3] gave them in some cases but not others, but states no conclusion about their effect. On theoretical grounds, to give no rest pauses would seem to have the disadvantage, that any decrease in speed, which occurred in the Y part of the test might be partly or wholly due to fatigue, and not to perseveration. Fatigue may be expected to come on rapidly, in a muscular activity done at maximum speed. On the other hand, if no rest pauses be given, perseveration effect may be lost between the X and Y parts of the test, at any rate, if it be assumed, with Biesheuval, that perseveration shows itself in difficulty in changing <u>quickly</u> from one activity to another. On the same assumption, to have only a short rest pause between one test and the next, would seem likely to cause a deterioration in the X part of the second one, due to the perseveration of the Y part of the previous one. On the other hand, it is a waste of time to give longer rest pauses than are necessary between tests.

ii. Subjects.

By the kindness of Mr Burnett, headmaster, permission was obtained to use as subjects a qualifying class in James Gillespie's High School for Girls. Originally/

Originally, there were fifty-two children in the class, but seven had to be discarded owing to absence. The ages of the forty-five, who were retained, ranged from 11 years 3 months to 13 years 5 months.

iii. Procedure.

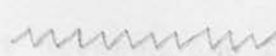
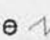
The experiment was done in May, June and July 1934. Three tests were given, two composed of short units and one of long. The two composed of short units were the Loops and Zig-zags Test, and the Long and Short Lines Test. In the X_1 part of the Loops and Zig-zags Test, the subject has to make continuous loops as fast as possible. In the X_2 part, he has to make continuous zig-zags, which must be sharp both at the top and the bottom. In the Y part, he makes the two alternately. The Long and Short Lines Test is done on specially prepared paper, with lines in groups of four and a gap between. In the X_1 part, the subject has to make vertical lines that cross three of the lines on the paper, but do not touch the fourth, or the lines above. In the X_2 part he makes vertical lines, that cross all the four lines on the paper, but do not touch those above or below. In the Y part he makes the long and the short lines alternately. The test involving "long" units was the Division Signs Test, invented by Professor Drever. In the X_1 part, the subject makes ordinary division signs, except that he begins with the dot instead of the line, a device adopted to make the difficulty equal to that of the/

the X_2 part. In the X_2 part he makes vertical division signs, and in the Y part he makes the two alternately. This test seemed to be an almost perfect alternation test, as the two parts appeared likely to be approximately equal in difficulty, and the form of the division sign was so definite, that subjects would not be likely to make any mistakes, as Biesheuval found they did in the Inverted S Test and the Triangles Test. Unfortunately, however, it turned out to have a considerable correlation with intelligence.

The tests are illustrated below.

Loops and Zig-zags Test.

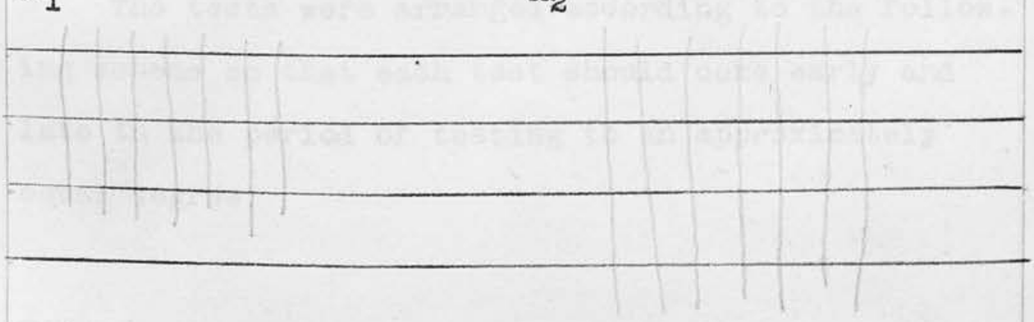
X_1 

X_2  (Here  is counted as one unit)

Y 

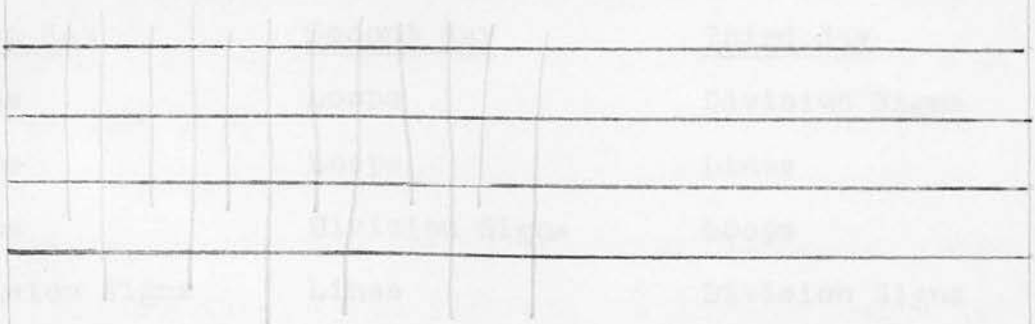
Long and Short Lines Test.

X_1 X_2



Y /

Y



Division Signs Test.

X_1

X_2

Y

The tests were given on seven days, usually at intervals of a week; there was an interval of a fortnight between the first and second day, and between the sixth and seventh. The time of testing was from about 2 to 3 P.M ; the testing took rather over three quarters of an hour.

The tests were arranged according to the following scheme so that each test should come early and late in the period of testing to an approximately equal degree:

First/

First day	Second day	Third day
Lines	Loops	Division Signs
Loops	Loops	Lines
Loops	Division Signs	Loops
Division Signs	Lines	Division Signs
Lines	Loops	Lines
Loops	Division Signs	Loops
Division Signs	Lines	Loops

Fourth Day	Fifth Day	Sixth Day	Seventh Day
Lines	Loops	Division Signs	Lines
Loops	Division Signs	Lines	(Loops)
Division Signs	Lines	Loops	Loops
Lines	Loops	Loops	Division Signs
Loops	Loops	Division Signs	Lines
Loops	Division Signs	Lines	Loops
Division Signs	Lines	Loops	Division Signs

The Loops Test, which is bracketed, was spoilt in the giving by a mistake in timing. The work done on the first three days was discarded as practice.

In all the tests, the X_1 and X_2 parts lasted thirty seconds and the Y part sixty seconds. In the Long and Short Lines Test and the Division Signs Test, no rest pauses were given between the parts, and the test was preceded by a rest pause of at least four, and usually five, minutes, since the preceding test. Thus fourteen identical trials of each of these tests were done altogether, and the last eight were included in the results. It will be noticed, that two trials of the Loops and Zig-zags Test were done in succession, and one separately. The first, of the two done in succession, had no rest pauses between its parts, and was preceded by a rest pause of four or five minutes. Three trials of this were included in the final average. The second of the two had no rest pauses between its parts, and was separated from the first by a pause of only one minute. Four trials of this were included in the final average. The one done separately had rest pauses of thirty seconds between its parts, and was preceded by a pause of four or five minutes. Four trials of this were included in the final average. The children occupied the longer rest pauses in reading, except, where these were needed for giving instructions and reading out/

out results.

On the first day the children were told that they were going to do "puzzles", in which they had to do things very fast, with as few mistakes as possible. Each test was then demonstrated on the board, before it was done for the first time; possible errors were shown and rubbed out, and the correct forms of all the tests were left on the board throughout the period of testing on the first day. On subsequent days the instructions were repeated as far as seemed necessary. The following are the possible errors against which the children were warned: In the Long and Short Lines Test, they were told that the lines must really cross the lines they were meant to cross, and not just touch them, that the short lines must not touch the lowest of the four lines on the paper, nor the set of lines above, that the long lines must not touch the sets of lines above and below, that the lines must be straight (that is, vertical) - it did not matter their sloping a little but they must not slope much - and that they must not touch each other. All these possible errors were shown. In the Loops and Zig-zags Test, they were told that the loops must be real loops with a clear white space inside, and was demonstrated as an error. The loops must not touch each other sideways; was shown as an error. They must not touch the ones on the line above or below, but anyone who liked might leave a line in between/

between to avoid this. They were told that the zig-zags must be sharp at the top and the bottom, and

 were shown as errors. In the Division Signs Test, they were told that they must be sure to make the dot first in the first part; if they found this difficult, they were to make the first few very slowly and their hands would soon get used to it. (A possible criticism of the Division Signs Test is that the difficulty, which some individuals have in making the dot first in the X_1 part, is itself due to a strong perseverative tendency. In a small preliminary experiment, one ten-year old child found it practically impossible to do this at all, and a student once reported that he found it difficult.) They were told not to make a line instead of a dot, thus, and not to let the dot touch the line, thus . In the X_2 part they were told to be sure to put in both the dots, and ·/·/·|· was shown as an error. They were told that, while they were to try not to make mistakes, they were not, if they did make one, to waste time altering it. It was difficult at first to get them to obey this instruction; on the first day some of them stopped during the tests to rub out errors.

The children were given a mark based mainly on speed, but with a deduction of one point for each error. On the second day of the testing, the names of those who had done best on the first day were read out/

out, and a list of all the marks was put up. After that, the names of those, who had improved most, were usually read out; this was done to give some chance of success to naturally slow writers. Individuals, who had made a large number of errors of one kind on the previous day, were criticised for doing it; this perhaps introduced an element of irregularity, owing to some individuals being thus differently treated from others, but it seemed necessary to do something to reduce the great number of errors, which some of the children were making in the Loops and lines Test. As will be shown later, it seems very improbable, that the general result of the experiment has been vitiated by any irregularity caused in this way.

In order to find whether there was any correlation between the perseveration score in the tests and intelligence, the National Intelligence Test, Scale A, Form 2 was given to the class.

The children were extremely friendly and cooperative; they never appeared to be discouraged by criticism, and remained interested and anxious to please right to the end of the testing. This was probably due partly to the good tone of the school, and partly to the fact, that the children took a great pride in the neatness of their handwriting, and the test appealed as a sort of writing exercise. Probably the amount of criticism, and of "don'ts" in the original/

original instructions, would have been excessive for most children. The children's pride in neatness was, as already noted, a drawback in some cases, leading to their probably not reaching the highest speed owing to excessive care. Others, however, sacrificed accuracy for speed far too much, especially after the first few days, and made an enormous number of errors. It seems likely, in fact, that the Lines and Loops Tests are in part a measure of how far an individual will sacrifice speed for neatness' sake or vice versa. This will be discussed later.

iv. Scoring.

A great deal of difficulty was experienced in scoring the tests, owing to the great amount of errors made. The first method of scoring tried was certainly too strict, and was discarded. The tests were then re-scored according to the rules which follow. These were probably still too strict, it seems likely from the results of Experiment III, in which the w Test was scored once with certain imperfect ws counted as errors, and once with all the ws made counted as correct, that more consistent results are on the whole obtained in a perseveration test, when all that is done is counted as correct. Two kinds of errors of course cannot be counted as correct, because they seem clearly due to the perseverative tendency, namely the repetition/

repetition of the same unit twice or more than twice in the alternation part of a test, as when a subject writes  , and the doing of one part of a test instead of another, or of a totally different test instead of the right one. The first of these will be called a "perseverative error" or "p error", and the second an "interference error".

Rules used in scoring the tests in Experiment I.

I. Short and Long Lines Test.

1. Fail line if there is any suspicion that it touches a line it should not.

2. Pass line as crossing a line it should cross if a part 1 millimetre long is to be seen on the other side however faintly.

3. If two lines touch each other, fail the second.

4. If a line has been retraced, that is, written a second time to correct an error, and if the second one is correct, pass it unless the first was a "perseverative error".

5. Never fail any line as too oblique.

6. A line was once failed for being very faint; the pencil had hardly touched the paper.

II. Loops and zig-zags Test.

1. Pass loop if there is either (a) clear white space inside and evidence of a rounded movement or (b)/

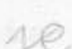
(b) very doubtful white space inside and whole loop is 2 mm. or more across when measured at right angles to its own axis.

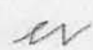
2. Pass rig-zag with break in it a bad joining, thus:

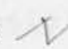
 if the gap is less than 2 mm. across.

3. Count  as error between two correct zig-zags.

4. Fail loop only if it definitely overlaps the previous one, not if it simply touches. Pass  or  but fail  .

5. Pass "muddled" loop or zig-zag if "muddle" can be reasonably regarded as due to bad joining; pass  or  .

6. Be fairly lenient about zig-zags where a "loop" movement may have been made, thus  . The degree of leniency was further defined by reference to particular children's papers.

7. Pass rig-zag which crosses at the top, thus  if the parts are less than 2 mm. long when measured from the centre of the line. (The lines were sometimes very thick).

6. Pass retraced loop or zig-zag if the second is correct unless the first was a "perseverative error".

III. Division Signs Test.

1. Do not fail division sign for touching another if it is properly formed itself.

2./

2. Fail if line, or "dot with tail", 3 mm. long or more, is substituted for the dot. Fail or

3. Fail division sign in which dot certainly touches line, but not if it barely touches or if its "tail" touches. Fail but pass

4. Fail if "dot" though less than 3 mm. long is longer than the line, thus,

5. Do not count extra dots or marks on the paper as errors.

6. Pass corrected mistake unless it was a "perseverative" error.

7. Fail ordinary division sign in which the line was made first. Here one is dependent on the subjects being honest enough to confess when they do this. Actually the children were very honest.

When the tests were scored according to these rules, there were few errors in the Division Signs Test, except in the case of one child who frequently substituted lines, more than three millimetres long, for dots, and whose scores were in consequence very different, from what they would have been, had all her division signs been counted as correct. In the Long and Short Lines Test, and the Loops and Zig-zags Test, there were, however, still a great many errors. In the end, the results were worked twice over. Once all the trials at the tests were included, except those in which the child had made more errors than/

than correct items, or in which some accident had happened such as the child's pencil breaking. The second time, those trials were discarded, in which there were twenty-one or more mistakes, or in which the mistakes if counted as correct would have made a difference of .21 or more to the perseveration score. This meant that the results from fifteen children were discarded altogether. The results for both groups will be given.

V. Results.

(a) Relationship between length of test units and size of perseveration score.

The following tables give the mean speed per thirty seconds of X_1 and X_2, taken together, and the mean perseveration score, for the two groups. The figure in brackets is the probable error.

Group/

Group of 45.

(Practically all the trials included)

	Speed of X_1 and X_2	Perseveration Score.
Lines Test	62.06 ($\pm$ 1.57)	1.55 ($\pm$ .03)
Loops Test with 30 sec. pauses.	87.59 ($\pm$ 1.68)	1.46 ($\pm$ .03)
Loops Test with no pauses and after 4-5 m. rest.	83.58 ($\pm$ 1.72)	1.49 ($\pm$ .03)
Loops Test with no pauses and after 1 m. rest.	85.75 ($\pm$ 1.76)	1.52 ($\pm$ .03)
Division Signs Test.	27.17 ($\pm$ .35)	1.16 ($\pm$ .02)

Group of 30.

(Trials with many errors discarded)

	Speed of X_1 and X_2	Perseveration Score.
Lines Test	57.62 ($\pm$ 1.81)	1.42 ($\pm$ .03)
Loops Test, with 30 sec. pauses.	84.34 ($\pm$ 2.18)	1.34 ($\pm$ .02)
Loops Test with no pauses and after 4-5 m. rest.	79.75 ($\pm$ 1.92)	1.37 ($\pm$ .02)
Loops Test with no pauses and after 1 m. rest.	82.25 ($\pm$ 2.11)	1.42 ($\pm$ .03)
Division Signs Test.	27.25 ($\pm$ .94)	1.16 ($\pm$ .02)

It is clear, that the tests with a higher speed in X_1 and X_2 combined, that is, with shorter units, have a very much higher perseveration score than the test with long units.

The mean speed of X_1 and X_2 was not worked out separately. From inspection of the results, one may say that, in the Long and Short Lines Test, X_2 was in many cases done more slowly than X_1, but in many others at the same speed. In the Loops Test X_2 was/

was done sometimes faster than X_1, sometimes more slowly, and sometimes at the same speed. In the Division Signs Test X_2 was practically always slower, sometimes considerably so.

Evidently the children, who make many errors, are on the whole those, who work fast in the Loops and Lines Tests. They also have higher perseveration scores on the average. It will be seen later, that there is a high correlation in these two tests between perseveration score and speed in the X part.

The Long and Short Lines Test is done decidedly more slowly, in the X part, than any form of the Loops and Zig-zags Test, but has a higher mean perseveration score in the group of 45, and as high a one in the group of 30, as the highest of the three Loops Tests. This suggests, that the relationship between length of test units and size of perseveration score, is not of the nature of a continuous change, the one increasing as the other does, but involves some more complex relationship. It has been suggested above, that it is impossible to find test items intermediate in speed between "long" and "short" items; possibly the perseveration score becomes abruptly high on the upper side of this "gap". Evidently, the preliminary definition of a "long" item, as one that is done at a speed of more than two per second, and a "short" item as one that is done at less, is not quite correct when applied/

applied to twelve-year old children, for, in the smaller group, the mean speed of the X part of the Long and Short Lines Test was less than two per second. In the case of these children the "gap" in speed, if there is a "gap", might come at about forty units per half minute.

The result of the Division Signs Test is practically identical for the two groups.

(b) <u>Effect on the Loops and Zig-zags Test of inserting, as against omitting, rest pauses between the parts, and of shortening the rest pause preceding the test.</u>

The effect on the Loops and Zig-zags Test, of different conditions as to rest pauses, can be studied from the preceding tables. In the larger group, none of the differences in speed or perseveration score are significant. In the smaller group, the perseveration score of the test with rest pauses is significantly smaller, than that of the test with no rest pauses and preceded by only one minute's rest. In other words, if the Loops and Zig-zags Test is given, with rest pauses and preceded by a pause of at least four minutes since a previous test, to a group of twelve year old girls selected for the fewness of their errors in a test of this type, it is very improbable that/

that the mean perseveration score of the group will be as high as 1.42. This does not seem to be a very important conclusion. The mean perseveration score of the test preceded by only one minute's rest has a larger probable error, so that it is not significantly greater than 1.34. (Throughout this investigation a figure is taken as significant if it is four times its probable error, or more.) The relative lowness of the perseveration score, in the test with rest pauses, is evidently due to Y being done at a greater speed than in the other two tests, for the speed of X is almost the same; in other words, either the perseveration score in the other two tests is falsely increased by fatigue, or the presence of a rest pause causes a loss of true perseverative effect.

c. Intercorrelation of Tests.

The following tables show the results of intercorrelating the perseveration scores of the different tests. The tests are arranged in hierarchical order.

Correlation/

Correlation Table : Group of 45.

	1	2	3	4	5
1. Loops, with rest pauses.	.	.80(±.04)	.79(±.04)	.56(±.07)	- .11(±.10)
2. Loops, without rest pauses, after 1 m. pause.		.	.82(±.03)	.44(±.08)	- .12(±.10)
3. Loops, without rest pauses, after 4-5 m. pause.			.	.44(±.08)	- .13(±.10)
4. Long and Short Lines.				.	.25(±.09)
5. Division Signs.					.

Correlation Table : Group of 30.

	1	2	3	4	5
1. Loops, with rest pauses.	.	.66(±.07)	.77(±.05)	.58(±.08)	- .22(±.12)
2. Loops, without rest pauses, after 1 m. pause.		.	.78(±.05)	.34(±.11)	- .14(±.12)
3. Loops, without rest pauses, after 4-5 m. pause.			.	.38(±.11)	- .29(±.11)
4. Long and Short Lines.				.	.24(±.12)
5. Division Signs.					.

The high correlations between the different forms of the Loops and Zig-zags Tests were to be expected. The correlation of the Division Signs Test with all the others is negligible. The really important question was, whether the Lines Test would have high correlations with the Loops Test. In the above tables, it has statistically significant ones, though they are not higher than the highest correlations previously obtained between perseveration tests. The above correlations are, however, explained away by the result to be given next.

d./

d. Correlation of Perseveration Score and Speed in the X part.

In order to find, whether the perseveration score was determined at all by the speed in the X_1 and X_2 parts of the test, these two values were correlated. The results follow.

Table of correlations of the mean perseveration score with the mean speed in the X part of the same test.

Group of 45.

Loops Test, with rest pauses, and after 4-5 m. pause	.58 (±.07)
Loops Test, without rest pauses, and after 1 m. pause	.66 (±.06)
Loops Test, without rest pauses, and after 4-5 m. pause	.65 (±.06)
Long and Short Lines Test	.78 (±.04)
Division Signs Test	.01 (±.10)

Group of 30.

Loops Test, with rest pauses, and after 4-5 m. pause.	.68 (±.07)
Loops Test, without rest pauses, and after 1 m. pause.	.73 (±.06)
Loops Test, without rest pauses, an d after 4-5 m. pause	.69 (±.06)
Long and Short Lines Test.	.71 (±.06)
Division Signs Test.	.10 (±.12)

In/

In the Loops and Zig-zags Test and the Long and Short Lines Test, the perseveration score is largely determined by the speed in the X part of the test, so much so, that it appears likely, that the speed in the X part, is the cause of the significant correlations between the perseveration scores. It was impossible to verify this by partialling out speed, as the measure of speed concerned was different for every test.

The above result could theoretically be caused in three ways, by the speed in Y tending to vary inversely with the speed in X_1, by the speed in Y not varying at all, or by the speed in Y tending to vary with the speed in X, but over a lesser range. The second possibility is obviously not the case, and on general grounds, and from inspection of the scores, the third seems more probable than the first.

In the Division Signs Test, in the case of the group of 30, the correlation, between perseveration score and speed in the X part, becomes - .56 with a probable error of .09, if the three subjects with the highest perseveration scores are eliminated. These subjects have mean perseveration scores of 1.75, 1.51 and 1.46 respectively. This is very curious, and suggests that the factors determining the score are complex. In the case of the group of 45, the correlation/

correlation with the highest scores eliminated was not worked out, but it can be seen from the correlation grid for all the subjects, that there is again a general tendency towards negative correlation between perseveration score and speed in the X part, which is upset by a few subjects, who have high perseveration and high speed. The grid will now be shown.

Correlation Grid for perseveration score and speed in the X part of the Division Signs Test for the group of 45.

Perseveration.												
1.70-9		LR 1						BD 1				
1.60-9												
1.50-9											MG 1	
1.40-9							HP 1					
1.30-9	EC 1		LA 1									MM 1
1.20-9				1	1	2						
1.10-9	NF NL 2		1	6	2	3	1		MR 1			
1.00-9		IM 1	1	2	3	1	1	2	WH 1			
.90-9					2		2	M.Bo 1	AM 1			
Speed.	40-42	43-5	46-8	49-51	52-4	55-7	58-60	61-3	64-6	67-9	70-72	73-5

The mean speed in all the three parts of the test of the subjects, whose positions on the grid are marked by their initials, was reduced to standard measure. Subjects B.D., H.P., M.G. and M.M., who have high perseveration and a high speed in X, are proportionately faster in X_1 than X_2, while subjects M.R., W.H., A.M. and M.Bo., who have low perseveration and a high speed in X, are proportionately faster in X_2 than in X_1. Subjects L.R., E.C. and L.A., who have high perseveration and a low speed in X_1, are also proportionately faster in X_2 than in X_1, while subjects M.F., N.L. and I.M., who have rather low perseveration scores and a low speed in X, are proportionately faster in X_1 than X_2. In other words, the tendency towards a negative correlation is caused by individuals, who find X_2 relatively easy compared with X_1, and may thus be due to a factor which is measured best by the speed in Y, less well by that in X_2 and least by that in X_1. It will be seen from the next result, that there is some evidence that this factor is intelligence. It is possible that the scores of B.D., H.P., M.G. and M.M. are due in part to their possessing a high degree of some speed ability, that is particularly well measured by the X_1 activity, and that M.F., N.L. and I.M. may be rather weak in this. All this is, however, extremely speculative.

e./

e. Correlation of intelligence with perseveration score.

Only thirty-seven of the subjects were present on the day of the intelligence test. The mean mental age was 14 years 3.04 months, with a standard deviation of 1 year 5.57 months, and a range of from 11 years 0 months to 17 years 7 months. As norms exist only up to the age of 15 years 0 months, mental ages above this were obtained by continuing the line of norms in the same direction. The mean intelligence quotient was 115.61, with a standard deviation of 12.16, and a range of 90.41 to 138.82.

A table of the correlations between mental age and perseveration score will now be given.

Table of correlations between mental age and perseveration score.

Loops Test, with rest pauses, and after 4-5 m. pause	.01 (±.11)
Loops Test, without rest pauses, and after 1 m. pause.	.04 (±.11)
Loops Test, without rest pauses, and after 4-5 m. pause.	- .02 (±.11)
Long and Short Lines Test.	.08 (±.11)
Division Signs Test.	- .42 (±.09)

In the case of the Loops and Lines Tests, the result is satisfactory; it is clear that they do not measure intelligence. The Division Signs Test correlates significantly with the mental age obtained from/

from the National Intelligence Test, and would thus appear to be unsuitable for use as a perseveration test, on the ground that it measures intelligence. There is, of course, also the possibility, that the National Intelligence Test really measures some speed factor. The question whether a speed factor enters into intelligence tests is a highly controversial one. Some psychologists claim to have proved, that intelligence tests do not measure a speed factor. For example, Dr Sutherland[42] gave the Otis Advanced Examination and the National Intelligence Test, Scale A, Form 2, to a group of students; the former, which is difficult, was intended as an unmistakeably valid measure of intelligence, and the latter, which was too easy for the subjects, and in which they were allowed insufficient time to finish, as a test which might show the presence of a speed factor. The parts of the National Intelligence Test were timed separately, and the intercorrelations of the times taken to do them appeared to depend mainly upon the factor measured by the Otis. Dr Sutherland thinks, that the time taken to solve even an easy intellectual problem, depends mainly on the number of steps, which the subject needs to take in thinking it out, and so is a good measure of his intelligence. May[25], Ruch and Koerth[36], and Walters,[47] all obtained correlations of over .9, between the scores for group tests done under the/

the standard conditions, and the scores for the same tests, when double time or unlimited time was allowed. A second group of investigators have obtained significant correlations between group intelligence test scores and speed in much simpler activities, and take the view that speed enters into the essential nature of intelligence. Peak and Boring[29] found a very high correlation, between the score in the Otis and Army Alpha tests and reaction time, but, as they used only five subjects, their result cannot be regarded as fully established. They think that intelligence is "power", and define the "unit of power" as "unit work in unit time". Travis[44] also once claimed to have found a close relationship between intelligence test scores and reaction time, and thought that the individual, in whom the speed of nervous conduction was greatest, was the best able to see relationships, because he had access to as many alternatives or judgments as possible, at approximately the same instant of time. Later, however, he contradicted his earlier result.[45] Into a third group, fall those psychologists who have obtained statistically significant correlations between group intelligence test scores and measures of speed, and take the view that the intelligence tests in question are therefore invalid. Highsmith[20] gave to three groups of children, aged approximately eleven, twelve and thirteen respectively, the/

the Stanford Revision of the Binet Scale, the National Intelligence Test, a linguistic rate test, and a non-linguistic rate test. The general trend of her results, which vary considerably in the different groups, is such as to suggest, that the National Intelligence Test is in part a measure of factors, measured by the linguistic rate test, and not measured by the Stanford-Binet. Farnsworth[12], Seashore and Tinker obtained a correlation of .53 between a serial action test and the Army Alpha Test, in a group of students for whom the latter was too easy. Miss McMeeken[26] has recently found that, in the case of a group of girls, aged approximately fourteen, and another aged approximately seventeen, certain parts of the Otis Test measure speed much more than they measure intelligence, but in a third group, aged approximately fifteen, the result of the same experiment was more doubtful. The bearing of all this on the present question is not clear; perhaps on the whole it suggests that the National Intelligence Test does measure speed. Farnsworth's result, and perhaps Miss McMeeken's, indicate that an intelligence test may measure speed, if it is too easy for the subjects, and the National Intelligence Test may be too easy for bright twelve-year olds. Dr Sutherland's result might seem to contradict this, by proving that the National Intelligence Test is valid for students, but it is also possible that even the Otis is too easy for/

for them. Highsmith's findings seem to prove, that the National Intelligence Test does in some degree measure speed, even in the case of children. It also seems inherently more probable that it should measure speed, than that so simple an activity as the Division Signs Test should measure intelligence. Against this, however, is the fact that the speed in the Y part correlates significantly with the mental age obtained from the National, while the speed in the X_1 and X_2 parts does not. The correlations of the speed in the three parts of the test with mental age are as follows:

$$r\,X_1.\,M.A. = .14\ (.11)$$

$$r\,X_2.\,M.A. = .23\ (.11)$$

$$r\,Y.\,M.A. = .47\ (.09)$$

Probably on the whole it is safest to assume, that the Division Signs Test does measure intelligence, and is therefore invalid as a perseveration test.

The above correlations suggest, that mental age may be the factor, which causes the negative correlation between perseveration and speed in X ; intelligent subjects will tend to have a high speed in X, but a still higher one in Y.

f./

f. Reliability Coefficients.

Reliability coefficients were obtained by dividing the trials, included in the final average for each test, into two groups, and correlating the average perseveration score for the one group with that for the other. For the Long and Short Lines Test, and for the Division Signs Test, the one group consisted of the first trials on the fourth and sixth days of testing, and the second trials on the fifth and seventh, and the other group of the remainder. For the Loops and Zig-zags Test with rest pauses, and for the one with no rest pauses and preceded by a minute's rest, the average of the trials on the fourth and sixth days was correlated with the average of the trials on the fifth and seventh. For the Loops and Zig-zags Test, given without rest pauses and preceded by a pause of four to five minutes, the average score of the trials on the fourth and sixth days was correlated with the score of the trial on the fifth. In the case of various individual children, the number of trials included in these averages was less than the total possible, either because of the child's absence on some days, or because of the discarding of trials on account of errors or accidents. Tables of the reliability coefficients follow.

Table/

Table of Reliability Coefficients.

Group of 45.

Loops Test, with rest pauses, and after 4-5 m. pause	.68 (±.05)
Loops Test, without rest pauses, and after 1 m. pause.	.81 (±.03)
Loops Test, without rest pauses, and after 4-5 m. pause.	.70 (±.05)
Long and Short Lines Test.	.83 (±.03)
Division Signs Test.	.77 (±.04)

Group of 30.

Loops Test, with rest pauses, and after 4-5 m. pause.	.49 (±.09)
Loops Test, without rest pauses, and after 1 m. pause.	.66 (±.07)
Loops Test, without rest pauses, and after 4-5 m. pause.	.74 (±.06)
Long and Short Lines Test.	.68 (±.07)
Division Signs Test	.76 (±.05)

These coefficients are fairly high, but it must be remembered that they are derived from averages of groups of tests. As a matter of fact, the averages cover a great deal of variation. For example, in the Long and Short Lines Test, one child had a score of 3.35 at the second trial on the fourth day, and of 1.47 at the first trial on the seventh day. There were two errors in the former trial and none in the latter/

latter, so that this irregularity is not even due to errors.

By the use of a formula kindly given to the writer by Dr Thoulèss of Glasgow University, an attempt was made to find, in the case of the Long and Short Lines Test and the Division Signs Test, whether the defect of the reliability coefficients from unity was wholly due to defects in the tests, that is, to real unreliability, or whether it was due partly to the function measured itself changing from day to day. The formula is as follows:

"The defect of a reliability coefficient from unity is due partly to change from day to day in the function measured, if

$r\,A_1 B_1\, r\,A_2 B_2 - r\,A_1 B_2\, r\,A_2 B_1 > 1$,

where A_1 and B_1 are two measurements made on one day, and A_2 and B_2 are two measurements made on a second day."

The formula can, of course, only be used, where the reliability coefficient is a test re-test coefficient, and not where it is a split reliability coefficient. In this experiment, in both the Long and Short Lines Test and the Division Signs Test:

A_1	was	the	first	trial	on	the	fifth	day
B_1	"	"	second	"	"	"	"	"
A_2	"	"	first	"	"	"	sixth	"
B_2	"	"	second	"	"	"	"	"

It seemed better not to use the results of the fourth day, as improvement from practice had not completely ceased by the end of the third trial, nor those of the seventh, because it was possible that on it irregularities had been caused by the children being too strongly exhorted to work carefully; also they were a little excited, because it was the last day of the term, and several of them missed single trials of the tests through having to do various errands. The results of the application of the formula are as follows:

<u>Long and Short Lines Test.</u>

$$r\ A_1\ B_1 = .64$$

$$r\ A_2\ B_2 = .58$$

$$r\ A_1\ B_2 = .33$$

$$r\ A_2\ B_1 = .54$$

$$r\ A_1 B_1\ r\ A_2 B_2 - r\ A_1 B_2\ r\ A_2 B_1 = .1930$$

<u>Division Signs Test.</u>

$$r\ A_1 B_1 = .44$$

$$r\ A_2 B_2 = .29$$

$$r\ A_1 B_2 = .21$$

$$r\ A_2 B_1 = .76$$

$$r\ A_1 B_1\ r\ A_2 B_2 - r\ A_1 B_2\ r\ A_2 B_1 = -.0320.$$

Thus/

Thus there is evidence for a day to day change of the function measured in the Long and Short Lines Test, but not in the Division Signs Test. This conclusion is not very important, when the nature of the function measured by the tests is still so uncertain, but the lowness and variability of the correlations between trials of the test is noteworthy. From the appearance of the correlation grids it seems likely that the three low correlations between different trials of the Division Signs Test would be considerably greater, if three or four children with very irregular scores were eliminated, but there is no reason for eliminating them; there is no obvious cause for the irregularity.

g. Discussion of results.

The two principal results of Experiment I are, that the two tests with a high speed in X had a much higher perseveration score, than the one with a low speed in X, and that, while these two tests had a fairly high correlation with each other, the perseveration score in them was largely determined by the speed in X. There remains to be considered the bearing on these results of the fact that some of the children made a great many errors in the Loops and Lines Tests, and of the possibility that others did not work at their maximum speed, because they set too/

too high a value upon neatness. It seems very improbable that the first conclusion is vitiated by this. Even in the group of 30, where those who made many errors were eliminated, the difference between the mean perseveration score for the Loops Test given with rest pauses - the form that had the lowest mean score - and that for the Division Signs Test, is nine times the probable error of each. While of course the probable error indicates only the degree of deviation from the real mean, that may have been caused by sampling, it seems highly improbable that the elimination of defects in the Loops Test, or alteration of the conditions in which it was given, as, for example, instructing the subjects to work much more carefully, would reduce the mean score to anything approaching that for the Division Signs Test.

It is quite possible, that the correlation between the Loops and Lines Tests may be partially determined by the degree of care with which children worked. It has been suggested, that the positive correlation between perseveration score in these tests and speed in the X part, may be caused by the speed in X being more variable than the speed in Y. If this is so, those, who appear as low perseverators in this test, may be those who work neatly, and those, who appear as high perseverators, may be those who sacrifice/

sacrifice neatness and accuracy for the sake of speed. The results of Experiment II show, that the perseveration score, in the Loops and Zig-zags Test, is decidedly greater, when the subjects try to work as fast as possible, than when they do not. The question then arises, whether tests composed of "short" units, are really measuring perseveration at all, even although they have the form of a perseveration test, and not some combination of motor ability, rhythm of work, degree of effort to work fast, and degree of willingness to sacrifice neatness.

CHAPTER III. EXPERIMENT II: CONFIRMATION OF PRINCIPAL PREVIOUS RESULTS, AND STUDY OF THE EFFECT ON THE SCORE IN PERSEVERATION TESTS OF DIFFERENT INSTRUCTIONS WITH REGARD TO SPEED.

i. Introduction and statement of problem.

Experiment II was originally planned as a study of three problems: whether, in the case of adults as well as children, a test consisting of "short" units gave a higher perseveration score than a test consisting of "long" units, what was the effect on perseveration tests of instructing subjects to work at their natural pace, as against that of instructing them to work as fast as possible,and whether creative effort tests were measuring the same factors as alternation tests.

It has already been suggested, that the "perseveration" score in the Loops and Zig-zags Test and the Long and Short Lines Test, is really due to factors such as rhythm, motor ability, and degree of effort. It seemed possible, that the score in tests consisting of more complex units, was really also determined by such factors as these, and that, if it could be established, that tests consisting of "short" units have, in adults as well as children, a higher perseveration score than tests consisting of "long" units, the way might/

might be opened for some further detailed study of what takes place in a perseveration test. That rhythm enters into tests with "long" units" is suggested by the fact, that in Experiment I, one child made very large dots in her division signs, thus: ÷ . This seems to be almost certainly due to a need to let the pencil dwell on the dot for a certain amount of time, in order to fulfil a rhythm. It also seemed possible, that the units generally used in perseveration tests were too complex, so that there was some "drag" in changing from one part of the unit to another. A friend, upon whom the Division Signs Test was tried out informally, said that she felt more "drag" in changing from a dot to a line, than in changing from a horizontal to a vertical division sign. Dr Leycester King said, in his paper read to the British Association for the Advancement of Science in the autumn of 1934, that he would like to try, instead of the Alphabet and Number Test, a test in which the X part was

A A A A A . . . . B B B B B . . . . C C C C C . . . .
D D D D D . . . . E E E E E . . . . F F F F F . . . .

and the Y part A B C D E F A B C D E F . . . , and that, in general, much more detailed study of the tests is needed. Unfortunately, while it has been further established, by means of Experiment II, that tests with "short" units do give a higher perseveration score than tests with long ones, the writer has never been/

been able to form any definite hypothesis about the detailed nature of the tests, or the part played by rhythm in them.

The second problem was suggested by Dr Collins, and the reason for it may be expressed as follows: If a difference in perseveration score is caused by the subjects' being instructed to work at their natural pace, instead of their being instructed, as is usually done, to work as fast as possible, then, even when they are instructed to work as fast as possible, there are probably uncontrollable disturbances in perseveration score, due to the different degree, to which the subjects obey the instruction to work fast. In other words, perseveration tests may be in part a measure of degree of effort, and not of perseveration at all. It has already been stated that there is some evidence that this is the case in tests with short units.

The assumption had usually been made, that creative effort tests and alternation tests were both equally good measures of perseveration. Biesheuval[3], as has already been noted, had taken the attitude that alternation tests were the true measures of perseveration, and Cattell[5] that creative effort tests were, but the majority of investigators had used both. Certainly the correlations between them were on the whole as high, as those of one alternation test with another/

another or one creative effort test with another, but where all the correlations were so low it seemed worth while to investigate the question further.

It was consequently decided to give three tests to two groups of subjects, who should receive different instructions as to speed, but should be treated in the same way in all other respects. The Loops Test was to be given as an example of an alternation test consisting of short units, the Division Signs Test as an alternation test consisting of long units, and Stephenson's **w** Test was to be given, and to be scored first as an alternation test, then as a creative effort test, than as a combination of both. The X_1 part consists of the writing of ordinary **ws**, the X_2 part of the writing of reversed **ws** and the **Y** part of the writing of the two sorts alternately. Consequently the score $\frac{X_1 + X_2}{Y}$ should give* a pure measure of the difficulty, which the subject encounters in alternating the two **ws**, as compared with the speed at which he writes each continually, the score $\frac{X_1}{X_2}$ gives a measure of the difficulty he finds in making reversed **ws** continuously, as compared with his speed in making ordinary ones continuously, and $\frac{X_1}{X_2} + \frac{2\,X_1}{Y}$ gives/

* It will be proved in Chapter V that it does not.

gives a combination of the two measures. This last is Stephenson's[40] method of scoring, though the lettering is different; the multiplication of the second fraction by 2 is necessary, because the time given for Y was to be double that given for X_1. The units of this test are, of course, "long".

Unfortunately, it proved impossible to obtain more than about fifty subjects, so it was necessary, either to form them into one group, and thus to sacrifice the second problem, or to form them into two groups, who should be given different instructions as to speed, and thus to sacrifice the third problem, as correlations obtained from two such small groups would be valueless. The second course was decided upon, and the problems to be studied in Experiment II were formulated as follows:

(1) To find whether, in the case of adults as well as children, a perseveration test, of the alternation type, composed of "short" units, gives, on the average, a larger perseveration score than tests, of the alternation type, composed of "long" units.

(2) To find the effect of (a) instructions to work as fast as possible, and (b) instructions to work at a natural pace, on the perseveration score, and the speed in the X part, of
(a) a test of the alternation type composed of "short"/

"short" units, (b) a test of the alternation type composed of "long" units, and (c) a test composed of "long" units, and capable of being treated either as a pure measure of difficulty in alternation, or as a pure measure of difficulty in creative effort, or as a combination of both.

Cattell[6] has since treated the problem, whether creative effort tests and alternation tests are measuring the same factor; his conclusions have been already discussed.

ii. Subjects.

The subjects were students in the Ordinary Psychology Class of Edinburgh University. Fifty-two of them completed enough of the programme of testing to be included in the final results. Of these, twenty-six, who will be called the "Monday Group", came on four successive Mondays from 10 to 11 A.M., and were instructed to work at their natural pace. Sixteen, who will be called the "Friday Group", came on four successive Fridays from 3 to 4 P.M., and were instructed to work as fast as possible. Ten, who will be called the "Wednesday Group", came on four successive Wednesdays, from 3 to 4 P.M., and were instructed to work as fast as possible. The Wednesday and Friday groups were treated exactly alike, except for a few minor differences in length/

length of rest pauses, and for an error in timing which made it necessary to discard one trial of the Division Signs Test in the case of the Friday Group. None of the subjects were told, that different groups were receiving different instructions, though it is impossible to be sure, that individuals did not find it out. In view of the fact, that Cattell[6] has recently found that, in the case of three school-boys, the perseveration score rose considerably through the day, it is perhaps a fault in the experiment, that the group, which was told to work at a natural pace, did the test in the morning, while the groups, which were told to work as fast as possible, did it in the afternoon. Cattell's finding was not published till after the conclusion of Experiment II, and, as has been pointed out, it is open to criticism because of the fewness of his subjects. It should however be borne in mind, in connection with the results of the present experiment. The Monday Group contained six men and twenty women, the Friday Group three men and thirteen women, and the Wednesday Group five men and five women.

iii. Procedure.

The experiment was done in November and December 1934. The three tests given were the Loops and Zigzags Test, the Division Signs Test and Stephenson's w Test. These have already been described. Ten trials/

trials of each were done, according to the scheme which follows, and the first five were discarded as a practice series.

<u>Scheme of Testing.</u>

First Day	Second Day	Third Day	Fourth Day
Loops	W	Division Signs	W
W	Division Signs	Loops	Loops
Division Signs	Loops	W	Division S
Loops	W	Division Signs	W
W	Division Signs	Loops	Loops
Division Signs	Loops	W	Division S
Loops	W	Division Signs	W
	Division Signs	Loops	

In every case except once, the X_1 and X_2 parts of the test lasted thirty seconds, and the Y part one minute. The exception is that, in the eight trial of the Division Signs Test, in the case of the Friday Group, the Y part was accidentally stopped after thirty seconds; the result of this trial was discarded. Rest pauses of thirty seconds were given between the parts of every test; once or twice they were lengthened by a few seconds. It seemed better to risk losing a little true perseverative effect, by the insertion of rest pauses, than to risk raising the perseveration score spuriously through fatigue. The/

The rest pauses between successive tests were usually three minutes in length; sometimes they were reduced to two minutes and twice they were raised, to three and a half and four minutes respectively. The reductions to two minutes were all on the last day; all the pauses were thus reduced in the case of the Wednesday Group, and the last four in the case of the Monday Group. It was suggested to the subjects, that they should count their score in the rest pauses, and they practically always did. This probably acted as an incentive to increase speed, so that the results of the tests would not be comparable with the results of tests, in which the subjects did not count their score. It seemed likely, that suggesting to the subjects that they should do this would increase their co-operativeness, besides preventing boredom. Probably it would be a good rule that subjects should always count their score in a perseveration test; in Experiment III they were not allowed to, and some found this restriction irksome, while others were unable to help counting as they worked.

On the first day, the students were given a short preliminary talk on perseveration, and on the purpose of the experiment. Each test was fully explained, with blackboard illustrations, before it was done the first time, and the subjects were warned against possible errors. In the Loops and Zig-zags Test, they were/

were told that the loops must be real loops, and must not overlap, and that the zig-zags must be sharp at the top and the bottom, being made with a jerky movement, and that the last zig-zag in a line would not count unless it was finished with a rising line, thus . In the w Test, they were warned against omitting the hook. In the Division Signs Test, they were told that it was an error if they substituted a line for a dot, or if they made the two dots beyond the end of the line, thus . Before every subsequent trial, the principal instructions were repeated, with emphasis on any, which there was a tendency to disobey. Individual subjects were never criticised for their errors. It was found necessary, on the second day, to say that the division sign must be begun from the dot in every part of the test, and that the lines of reversed ws must not be begun from the right-hand side of the page.

The students were asked to write a note on their paper, if they found any test, a part of a test, specially easy or specially difficult, or if they were fatigued, and were told that they might give any other introspection they wished. From the second day onwards, they were also asked to localise any fatigue as accurately as possible. On the first day, they were asked to say if they felt general fatigue or staleness at the end of the hour, so that the programme/

programme of testing might be cut down, if it was proving too heavy; only one or two, however, were generally tired.

After the last test, the students were given their results for the first two days of testing, and early in the following term they were given their average perseveration score for the last five trials of each test. The prospect of being told their results may have acted as an incentive to co-operate fully in the test. On the whole they seemed interested in it, and some in the Wednesday and Friday Groups took an obvious pride in trying to increase their speed. One or two questioned the usefulness of the experiment; it is not clear, whether this attitude had any effect on their performance in it.

The scores of students, who were absent on either of the first two days, were discarded from the final average, on the ground that they had not had the proper amount of practice, but where a student was absent on the third or the fourth day only, the scores for the other of these two days were used alone. One of the Wednesday Group was absent on the fourth day, one of the Monday Group on the third, and seven of the Monday Group on the fourth.

iv./

iv. Scoring.

The score for the Loops and Division Signs Tests was $\frac{X_1 + X_2}{Y}$, and the w Test was scored by the three methods $\frac{X_1 + X_2}{Y}$, $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2\,X_1}{Y}1$.
In every case, the last five trials of the test were included in the final average, or as many of these as were available, in the case of subjects who had missed some through absence. Great difficulty was again experienced in scoring, in particular in the Loops Test, because subjects made so many errors. The tests were scored according to the following rules, which were more lenient than those used in Experiment I, but this increase in leniency did little to reduce the errors. The continuous zig-zags frequently degenerated into a wavy line, and, in some cases, all the zig-zags in the Y part of a test had to be counted as errors, because they were rounded.

Rules used in scoring the tests in Experiment II.

I. Loops and Zig-zags Test.

1. Fail loop only if there is no white space in it and no evidence of a rounded movement. This was further defined by reference to a particular loop which was just passed and another which was just failed.

2. Fail zig-zag which is rounded at the top or bottom.

3./

3. Fail loop which definitely overlaps previous loop or zig-zag.

4. Fail zig-zag which crosses at the top or bottom if the projecting parts are more than two millimetres long.

5. Fail zig-zag with gap of more than two millimetres at the top or bottom.

II. Division Signs Test.

1. Fail division sign in which a line over three millimetres long is substituted for a dot.

2. Fail division sign in which the dots can be joined without touching the line, thus 

III. w Test.

1. Pass any w in which three movements, that is, two main parts and a hook, have been made, to however slight a degree, unless the result is so out of proportion as to be unrecognisable as a w. Fail w in which any movement is completely omitted.

2. Fail w in which there is a distinct extra hook or main part, thus 

IV. General.

1. Pass any corrected mistake even if it was a "perseverative" error.

2. If a line in the alternating part of a test is begun/

begun with the same item as was at the end of the previous line, the one at the beginning of the new line is an error.

Cases in which there was doubt whether there was an error or not according to these rules were scored leniently, but it is probable that the rules themselves were too strict.

V. Results.

a. Mean perseveration score and mean speed in X.

The following tables give the mean perseveration score, and the mean speed per thirty seconds in X_1 and X_2, taken together, for the two groups.

Monday Group.

	Mean perseveration Score.	Mean speed in X.
Loops Test	1.425 ($\pm$.04)	98.85($\pm$3.36)
Division Signs Test.	1.02($\pm$.0054)	36.50($\pm$.71)
w Test, scored $\frac{X_1 + X_2}{Y}$	1.03($\pm$.0046)	35.92($\pm$.72)
w Test, scored $\frac{X_1}{X_2}$	1.34 ($\pm$.02)	-
w Test, scored $\frac{X_1}{X_2} + \frac{2 X_1}{Y}$.	2.51 ($\pm$.03)	-

Wednesday and Friday Groups.

	Mean persevera-tion Score.	Mean speed in X.
Loops Test	1.84 ($\pm$.06)	119.62 ($\pm$2.43)
Division Signs Test.	1.06 ($\pm$.0109)	35.65 ($\pm$.54)
w Test, scored $\frac{X_1 + X_2}{Y}$	1.03 ($\pm$.0084)	37.58 ($\pm$.65)
w Test, scored $\frac{X_1}{X_2}$	1.36 ($\pm$.02)	-
w Test, scored $\frac{X_1}{X_2} + \frac{2X_1}{Y}$	1.52 ($\pm$.03)	-

The alternation test consisting of short units has a very much higher perseveration score in both groups, than either the Division Signs Test, or the w Test, when it is scored purely as an alternation test. Thus the main finding of Experiment I is confirmed. If all the errors were counted as correct, the mean perseveration score of both groups in the Loops Test would be even larger than it is, as most subjects made more errors in X than in Y. In the Wednesday and Friday group, all the mean scores for the Loops Test are higher than those for the Division Signs Test, and for the w Test scored by the method $\frac{X_1 + X_2}{Y}$ The lowest mean score obtained by any subject/

subject in the Loops Test was 1.28, the highest mean score obtained by anyone in the Division Signs Test was 1.25, and the highest mean score obtained by anyone in the w Test, scored by the method $\frac{X_1 + X_2}{Y}$, was 1.185. Scores in single trials overlapped a little; one subject once had a score of 1.71 in the Division Signs Test, and another one of 1.44, and a few scores between 1.20 and 1.30 were obtained in both the Loops Test and the w Test. In the Monday Group, the mean scores of subjects in the Loops Test overlapped those in the other two alternation tests to a certain extent. The two lowest mean scores in the Loops Test were .75 and .95, and there were five others under 1.20. The highest mean score in the Division Signs Test was 1.16, and in the w Test scored as a pure alternation test the highest was 1.185.

In the Loops Test the subjects, who worked as fast as possible, had a significantly higher perseveration score, and a significantly higher speed in X, than those who worked at their natural pace. This proves that speed in the X part of such a test can be varied at will to a greater extent than speed in the Y part. In the Division Signs Test, the mean perseveration score of the Monday Group is significantly lower, than that of the Wednesday and Friday Group. The latter is not, however, significantly higher/

higher than the former. The mean speed in the X part of the Division Signs Test and of the w Test, and the mean perseveration score of the latter, by all three methods of scoring, are practically identical for both groups. This is a most surprising result. Evidently, degree of effort to work fast has, at any rate in the case of normal adults who are cooperating in the test, practically no effect on the speed of the w Test or the X part of the Division Signs Test, and may actually cause the Y part of the Division Signs Test to be done more slowly, than when the subjects work at a natural pace. It is possible, that any test unit, except the simplest, is naturally performed in a rhythm, which enables the maximum speed to be reached without effort, and that efforts to surpass this are ineffectual, or may even cause confusion. The small effect of effort on speed is the more surprising, in view of the fact, that the speed of an individual's handwriting can be altered voluntarily. Possibly the repetitive character of a perseveration test favours the effortless development of a rapid rhythm in performing it. Also, in increasing one's speed of handwriting, one perhaps sacrifices accuracy of form more than the most careless subject does in a perseveration test. It is of course quite possible, that the above finding might not hold in the case of children, whose motor abilities were not matured/

matured, or of adults who were in an abnormal emotional condition, or who had a hostile attitude to the test. Another explanation of the facts might be, that the Monday Group disobeyed the instruction to work at their natural pace, because they felt impelled by the general conditions of the test to work fast, but the fact, that they worked significantly more slowly than the Wednesday and Friday Group in the X part of the Loops Test, argues strongly against this. Also they made fewer errors, on the average, than the Wednesday and Friday Group in all three tests, though the difference is in no case statistically significant.

As the scoring was a little more lenient in Experiment II than in Experiment I, the results of the two experiments are not strictly comparable, but it seems likely, that adults tend to have a lower score than children, in an alternation test consisting of long items, and a higher one in one consisting of short items. As would be expected, their speed is greater.

b. Intercorrelation of Tests.

The following tables give the correlations between the tests, in hierarchical order; it seemed worth while to work these out, even although, owing to the smallness of the groups, they are not very valuable.

Correlation/

Correlation Table: Monday Group.

	1	2	3	4	5
1. w Test, scored $\frac{X_1}{X_2} + \frac{2X_1}{Y}$	.	.94 (±.02)	.65 (±.09)	- .06 (±.13)	- .11 (±.13)
2. w Test, scored $\frac{X_1}{X_2}$		.	.35 (±.12)	- .05 (±.13)	- .05 (±.13)
3. w Test, scored $\frac{X_1 + X_2}{Y}$			.	- .07 (±.13)	- .41 (±.11)
4. Division Signs Test.					.08 (±.13)
5. Loops Test.					.

Correlation Table: Wednesday and Friday Group.

	1	2	3	4	5
1. w Test, scored $\frac{X_1}{X_2} + \frac{2X_1}{Y}$	.	.90 (±.03)	.21 (±.13)	.40 (±.11)	.12 (±.13)
2. w Test, scored $\frac{X_1}{X_2}$		.	.04 (±.13)	-.15 (±.13)	.17 (±.13)
3. Division Signs Test.			.	.41 (±.11)	.10 (±.13)
4. w Test, scored $\frac{X_1 + X_2}{Y}$				.	.02 (±.13)
5. Loops Test.					.

The high correlation between the w Test, scored by the method $\frac{X_1}{X_2}$ and the w Test, scored by the method $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, was to be expected, since the one score contains the other. Apart from this, the only statistically significant correlation is between the w Test, scored by the method $\frac{X_1 + X_2}{Y}$, and the w Test, scored by the method $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, in the case of the Monday Group.

c. Correlation of perseveration score with speed in the X part of the tests concerned.

The table, which follows, gives the correlation coefficients between the mean perseveration score of each subject and his mean speed in the X_1 and X_2 parts of the test in question, taken together.

Table of correlations between perseveration score and speed in the X part of the same test.

	Monday Group	Wednesday and Friday Group
Loops Test	.74 ($\pm$.06)	.34 ($\pm$.12)
Division Signs Test.	.13 ($\pm$.13)	.22 ($\pm$.13)
w Test, scored $\frac{X_1 + X_2}{Y}$	.03 ($\pm$.13)	.02 ($\pm$.13)

The high correlation between perseveration score in the Loops Test and speed in the X part, in the case/

case of the Monday Group, bears out the finding of Experiment I, but, in the case of the Wednesday and Friday Group, the correlation is not statistically significant. This may be an effect of the large number of errors, or of the smallness of the group. The other correlations between perseveration and speed are very small, which is satisfactory, though results from such small groups cannot be conclusive.

d. Reliability Coefficients.

Reliability coefficients were obtained, in the case of the Loops Test and the Division Signs Test, by correlating the average score for the sixth, eighth and ninth trials with that for the seventh and tenth. In the case of the w Test, the average score for the sixth, eighth and tenth trials was correlated with that for the seventh and ninth. The trials to be included in the same average were chosen so as to equalise out, as far as possible, effects of the trial being done early or late in the testing hour. The following table gives the reliability coefficients.

Table/

Table of Reliability Coefficients.

	Monday Group	Wednesday and Friday Group.
Loops Test	.93 (±.02)	.95 (±.01)
Division Signs Test.	.69 (±.06)	.59 (±.08)
w Test, scored $\frac{X_1 + X_2}{Y}$	.34 (±.12)	.49 (±.10)
w Test, scored $\frac{X_1}{X_2}$	.66 (±.07)	.65 (±.07)
w Test, scored $\frac{X_1}{X_2} + \frac{2X_1}{Y}$	.68 (±.07)	.65 (±.07)

Even for such small groups, the reliability of the w Test, scored as a pure alternation test, is appallingly low. It is strange that the Loops Test, in which a very great number of errors was made, should be so reliable. Of course, the number of errors made by each subject had a certain degree of constancy from trial to trial. In addition, the total number of loops and zig-zags made in this test is so great, that irregularities have less effect on the perseveration score, than in other tests. The "ratio method" of scoring has the effect, that differences in the speed of a part of the test, between one trial and another, cause a large alteration in the perseveration score, in a test where the speed is low, and a small one where it is high.

e. <u>Day to day variations of perseveration score.</u>

In addition to the working out of reliability coefficients, in the way described above, the mean perseveration score for each of the last two days was found, and the difference between these two averages was converted to standard measures. The results, which follow, show that, even when the perseveration score is the average score for two or three tests, it changes considerably between one day and another, except in the case of the Loops Test. The standard deviation used was, of course, that of the subjects' mean scores for the last five trials of the test concerned.

<u>Monday Group</u>. (18 subjects were present on both days).

<u>Loops Test</u>. <u>$\sigma = .31$</u>.

5 scores changed by over $\frac{1}{2}\sigma$ but less than 1σ.

The remaining 13 scores changed by less than $\frac{1}{2}\sigma$.

<u>Division Signs Test</u>. <u>$\sigma = .04$</u>

7 scores changed by more than 2σ.

4 " " " " " 1σ but less than 2σ.

3 " " " " " $\frac{1}{2}\sigma$. " " " 1σ.

The remaining 4 scores changed by less than $\frac{1}{2}\sigma$.

w /

<u>w Test, scored $\frac{X_1 + X_2}{Y}$ $\sigma = .03$.</u>

8 scores changed by more than 2 σ.

8 " " " " " 1 σ but less than 2 σ.

1 score " " " " $\frac{1}{2}\sigma$ " " " 1 σ.

1 score changed by less than $\frac{1}{2}$ σ.

<u>w Test, scored $\frac{X_1}{X_2}$ $\sigma = .13$</u>

6 scores changed by more than 1 σ but less than 2 σ.

5 " " " " " $\frac{1}{2}\sigma$ " " " 1 σ.

The remaining 7 scores changed by less than $\frac{1}{2}$ σ.

<u>w Test, scored $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ $\sigma = .22$</u>

4 scores changed by more than 1 σ but less than 2 σ.

8 " " " " " $\frac{1}{2}\sigma$ " " " 1 σ.

The remaining 6 scores changed by less than $\frac{1}{2}$ σ.

<u>Wednesday and Friday Group</u>. (25 subjects were present on both days.)

<u>Loops Test. $\sigma = .44$.</u>

1 score changed by more than 1 σ but less than 2 σ.

4 scores " " " " $\frac{1}{2}\sigma$ " " " 1 σ.

The remaining 20 scores changed by less than $\frac{1}{2}$ σ.

<u>Division Signs Test. $\sigma = .08$</u>

3 scores changed by more than 2 σ.

6 " " " " " 1 σ but less than 2 σ.

2 " " " " " $\frac{1}{2}\sigma$ " " " 1 σ.

The remaining 14 scores changed by less than $\frac{1}{2}$ σ.

w /

$\underline{\text{w Test, scored } \frac{X_1 + X_2}{Y}. \quad \sigma = .06.}$

4 scores changed by more than 2 σ.

9 " " " " " 1 σ but less than 2 σ.

10 " " " " " $\frac{1}{2}$ σ " " " 1 σ.

The remaining 2 scores changed by less than $\frac{1}{2}$ σ.

$\underline{\text{w Test, scored } \frac{X_1}{X_2} \quad \sigma = .13.}$

2 scores changed by more than 2 σ.

5 " " " " " 1 σ but less than 2 σ.

12 " " " " " $\frac{1}{2}$ σ " " " 1 σ.

The remaining 6 scores changed by less than $\frac{1}{2}$ σ.

$\underline{\text{w Test, scored } \frac{X_1}{X_2} + \frac{2X_1}{Y} \quad \sigma = .20.}$

3 scores changed by more than 2 σ.

8 " " " " " 1 σ but less than 2 σ.

5 " " " " " $\frac{1}{2}$ σ " " " 1 σ.

The remaining 9 scores changed by less than $\frac{1}{2}$ σ.

A detailed analysis was made, in the case of the Wednesday and Friday Group, of the causes of the change in score between the third day and the fourth. The general conclusion was that the variation is largely, but not solely, due to the fact that improvement from practice has not ceased. Also, in some cases in which the score remains constant, there has been an increase in speed in both X and Y.

<u>f. Subjects' introspections.</u>

It was hoped that the subjects' introspections, as to where they were fatigued, might throw light on the/

the particular muscles used in performing the tests, and hence on the nature of the processes involved. Fatigue was, however, localised in practically every part of the hand or arm by one subject or another, so that no conclusion could be drawn. Many of the other introspections are, however, interesting.

A fairly large number of introspections state that the test was done rhythmically, and that this was a help. Rhythm seems to have played an especially large part in the Y part of the tests. It seems most often to have been connected, either with the sound of the pencil, or with the subject's naming the items to himself. One subject began, at a certain point, to count the items in the Y part of the Loops Test, in order to provide himself with a "metre", and two others said "dot dash dot" inwardly, as they wrote vertical and alternating division signs. Another spoke of the "change of noise" of the pencil as helpful. Several subjects were distracted, at times, in the Division Signs Test, by the sound of their neighbours' pencils, and this happened once in the Y part of the Loops Test. One or two followed their neighbour's rhythm, or tried to follow it, while on other occasions subjects tried to overcome the distraction. On one occasion a subject, after trying to follow a neighbour's rhythm in the X_2 part of the Division Signs Test, tried to overcome the distraction in Y.

An/

An introspection, such as the following, suggests the formation of a visual gestalt rather than of an auditory-motor rhythm: "In the alternating part there is a tendency for $\div$ to predominate over ·|· ." Two subjects said that they wrote alternately faster and more slowly in the Division Signs Test; this seems to be some rhythm of work of a longer duration, than the rhythm connected with the sound or feeling of making the test units. It might possibly be connected with fluctuations of attention, periods of deliberate effort to work fast alternating with periods of automatic work, but the fact, that one of the two subjects was a member of the Monday Group, tells against this. One set of introspections throws light on a certain subject's interpretation of the instructions. A subject, who was usually the slowest writer in the Monday Group, except in the **Y** part of the Loops Test, seemed to have considerable difficulty in settling down to a pace which suited him. On the second day, he repeatedly mentioned stiffness in the elbow, and said, about half way through the testing on that day, that he was going to try a slower and more natural pace in order to avoid it. His speed in all the tests was much less on the third day, but he still had some stiffness, first in the elbow and then in the shoulder. Evidently, his conception of a natural pace was one which caused no subjective fatigue.

One/

One subject in the Monday Group said, after the sixth trial of the Loops Test, that she found it impossible to increase her speed. She, at any rate, appears to have disobeyed the instruction to work at a natural pace.

A number of introspections deal with the question, whether the tests were done automatically or required attention. All the parts of the Loops Test and of the Division Signs Test were reported by some subjects to be done automatically, by others to require attention. No member of the Monday Group said that any part of the Loops Test required attention; in other words, it appears that this test is often done automatically when it is done at a natural pace. The w Test was spoken of as automatic, or becoming so, by several subjects in both groups. It was never said by anyone to require attention, but several of the introspections imply, that one or another part of it had required attention earlier in the testing, but became automatic part of the way through. Two subjects said, that the Y part of the Division Signs Test was mechanical except at the beginning of each new line, where an effort of attention had to be made; one of them thought that the effort was necessary, because she could not name the figures to herself, as in the other two tests. No conclusion can be drawn, as to whether there is any connection between the persevera-tion/

perseveration score and the degree, to which subjects find a test automatic, as the introspections on the matter are too few. There is perhaps a very slight tendency for subjects, who find that the Y part of the Division Signs Test requires attention, to have a high score in it.

Some subjects gave introspections on whether the tests were interesting or boring. As might be expected, it was the more difficult parts of the tests that were found interesting, namely the Division Signs Test as a whole and the alternating part of the w Test.

Some introspections gave reasons for the making of "perseverative" errors. They were said to be due to distraction or wandering of attention, on three occasions in the Loops Test, and on two occasions in the Division Signs Test. An "interference" error in the Division Signs Test was said to be similarly caused. It is interesting that some of these errors should have been attributed to this cause. It raises the question, whether the "perseverative" errors, made by Stephenson's[40] psychotic subjects, were due to distraction by their own thoughts. Other reasons given by subjects for making such errors were fatigue, in one instance, and in one instance, the attempt to keep the division signs in columns. Two in succession in one trial were said to have been made quite unconsciously.

A/

A number of introspections suggest, that a difficulty of a kind, that really seems due to some sort of perseverative tendency, is felt sometimes in the Y part of the Division Signs Test and the w Test. A bare statement, that there is difficulty in changing from a horizontal to a vertical division sign, or from a rounded to an angular movement in the Y part of the Loops Test, may be the result of suggestion given by the instructions or the preliminary talk, but introspections, such as the following, do not sound like the mere result of suggestion:

"I got confused here. I could not think what sign came next". (Division Signs Test, sixth trial, Monday Group)

"Very intense concentration was needed for this test; otherwise the series was inclined to become completely disarranged". (Division Signs Test, sixth trial, Monday Group.)

"Became rather muddled as to the order, about the middle". (w Test, fifth trial, Friday Group)

"Find it difficult to make ordinary w after forming the letter backwards" (w Test, first trial, Friday Group).

The first three of these introspections suggest that the difficulty is one of keeping the right idea in mind, and fit in with Stephenson's[41] view, that the difficulty of a perseveration test is greatest, when the/

the idea of the more familiar one is being attempted. The fact, that several subjects found it a help, in the Y part of the Division Signs Test, to copy the line above, supports the same view. (One subject tried to resist the tendency to do this, because she thought it an infringement of the test conditions; it is a fault in the test, that what is done in it should thus depend, to some extent, on the subject's conscientiousness.) A rather different kind of difficulty is suggested by a subject, who said that the X_2 part of the Division Signs Test was difficult, because the hand had got into the swing of the X_1 part. Confusion of ideas does not seem to have occurred in the Loops Test, but only difficulties connected with the unlikeness of the two movements in the Y part. The following introspection suggests, that the subject, who wrote it, felt difficulty in passing from the dot to the line in each unit of the Division Signs Test:

> "If the line is a big line, I find a difficulty in putting the dot beneath it. If it is a small line, then I am apt to put another small line beneath it."

Such a difficulty might be attributed to the perseverative tendency, but might also be due to the nature of the writing movements concerned. The result of the Lines Test shows that it is much easier to repeat a line of the same length, than to alternate two lines of different lengths, and it is probable that it is similarly/

similarly more difficult to change from a dot to a line, than to make a succession of dots or lines. Also, as Saudek points out, to make a real dot involves a complete stoppage of the writing movement. The whole subject of writing movements should probably be studied much more thoroughly in connection with motor tests of perseveration.

Two subjects stated, that they found the X_2 part of the Division Signs Test easier, when they thought of the two adjacent dots as grouped together, thus: ·1 ·· 1 ·· 1 · This is probably connected in some way with the need to form a rhythm. Another subject said that she wanted to omit one of the dots. Some of the children in Experiment I actually did omit one of the dots, in their earlier attempts, while others ended a line with a "division sign" having three dots, thus ·1 ··

The two following introspections suggest a difficulty, due probably to some disturbance of the process, whereby the work became automatic:

"At the place marked I suddenly thought they should look different and could not think of the method I had just used."

"Some moments it seems automatic, then I suddenly wonder just what I am trying to do."

One subject said that, since doing the tests, she had not been able to write ws at other times without thinking/

thinking specially about it; thus a process ordinarily automatic was disturbed by the test.

Many subjects find the Y part of the tests easier than the X_2 part. This may be because a rhythm is formed more readily in the Y part, or because the two items in the Y part are perceived as a unit. Some subjects did say, that they perceived the two items in the Y part as a unit, but they were not always those, who found it easier than the X_2 part. Subjects, to whom Y feels easier than X_2, seem to tend to have low scores in the Loops Test and the Division Signs Test, but not in the w Test. One subject said that, in the Y part of the w Test, he seemed to himself to be anticipating the difficulty of the reversed w, as he made the ordinary one. A small number of subjects stated, that they found the Y part of the Division Signs Test and of the w Test harder than the X_2 part. These introspections were almost all made after the earliest trials, and one subject found the Y part of the Division Signs Test harder than the X_2 part at the first trial, and easier at the seventh. It is possible, that the difficulty in alternating is partly one at a high mental level, a difficulty in remembering what comes next, which is overcome comparatively quickly, while the difficulty in forming a reversed w, or a vertical division sign, is at a motor level, and is overcome/

overcome more slowly.

The fact, that some students perceived the two items in the Y part as a unit, is interesting, because one criticism made of perseveration tests is, that the more intelligent subject unifies the items more readily, and that thus the tests are in part a measure of intelligence. The intelligence of the subjects in Experiment II is not known, but it seemed worth while to investigate the question, whether the speed in the Y part increased when the items were unified. The results are conflicting. In the case of three of the Wednesday and Friday Group, in the Loops Test, and one of the Wednesday Group, in the Division Signs Test, the speed of Y increased pronouncedly in the trial, after which the subject reported that he or she had begun to unify the items: In the case of one of the Monday Group, in the Loops Test, one of the Wednesday Group, in the Division Signs Test, and one of the Wednesday Group, in the w Test, there was a pronounced increase in speed, in the trial following the one, in which the items were first unified. On the other hand, in one of the Wednesday Group, in the Loops Test, and one of the Friday Group, in the w Test, there was practically no increase in speed at the trial in question, and one of the Friday Group actually showed a decrease, when he began to unify the two items in the Loops Test/

Test. One of the Friday Group unified the two items in the Y part of the Division Signs Test throughout the testing. Her mean score for the last five trials is 1.02, which is certainly rather low.

The two following introspections, both made by a member of the Wednesday Group, who took a great pride in her speed, confirm the finding, that speed can be altered at will much more readily in the X part of the Loops Test, than in the Y part:

"In making loops (that is, in X_1) more than in any of the other tests, it always seems possible to speed up just a little more. Although trying to go as fast as possible all the time, when I try I find I can speed up a little more at any time."

"I found part 3 of this test (that is, the Y part), the most difficult of all to-day, in which to get up a conscious feeling of speed."

One subject wrote the following rather curious introspection about the X_2 part of the Loops Test:

"In part 2 conscious of not having determined in advance how high or at what angle the zig-zag should be written. This seemed to hinder progress."

In the next trial he said that he determined the size at the word "Ready", and felt he progressed better. One wonders, whether the need to determine the size is connected with the fact, that the zig-zag involves a complete stoppage of movement at the top and bottom, which/

which must, of course, be prepared for by a gradual slowing. This individual was extremely neat and self-critical, and said at the end that he thought he could have worked faster, but that if he had done so, he would not have done the tests well, and would have been dissatisfied.

Some of the introspections on the w Test suggest that the difficulty in reversing a writing movement is of a peculiar nature, perhaps somehow connected with handedness. One wonders how left-handed subjects would do the test. Two subjects said, that they felt as if they were using their left hands when doing the test, and one said that she wanted to use hers. Several said that, after making a reversed w in the Y part, they wanted to put the hook on the wrong end of the ordinary w that followed it. One actually did this frequently in the first two trials, but said that the desire to suddenly ceased at the third. Another did it on a single occasion. Another, Subject P of Experiment III, who was discarded from Experiment II on account of absence, frequently put the hook on the wrong end of his reversed ws in the earlier trials. It is possible, that left and right movements are more easily confused, than backwards and forwards, or up and down, ones. Certain facts support this view. Children frequently confuse their right and left hands. A student, who was doing a mirror-drawing/

mirror-drawing experiment as part of her class work, once told the writer that she found movements towards and from the body much easier to learn than right and left ones. If this is so, an element of difficulty is entering into some perseveration tests that does not enter into others.

g. "Perseverative" Errors.

If the "perseverative" errors, made in a test, and the perseveration score are both determined by the perseverative tendency, the largest number of such errors should be made by the subjects with the highest score. The number of "perseverative" errors made by each subject were therefore counted, in order to find whether this was so. The general conclusion is that there is little, if any, correspondence between the number of "perseverative" errors made and the size of the perseveration score, except possibly in the Division Signs Test, in the Wednesday and Friday Group. This cannot, however, be regarded as final, as the tests used in Experiment II are not wholly satisfactory, for the Loops Test is a new type of test, which may not be measuring perseveration, the Division Signs Test correlates significantly with intelligence, and the w Test is not very reliable. Also the total number of "perseverative" errors made was rather small.

In the Loops Test, where the number of "perseverative"/

"perseverative" errors was greatest, the mean number per trial for all the ten trials was found, and was correlated with the mean perseveration score for the last five trials of the test. The correlation was .12 ($\pm$ .13) for the Monday Group and - .01 ($\pm$ .13) for the Wednesday and Friday Group. In the case of the Division Signs Test, too few "perseverative" errors were made for it to be reasonable to work a correlation, but the following tables show the number of such errors, made by each subject, together with his or her perseveration score.

Monday Group.

Subject	No. of "p" errors	Mean p-score.
Con:	5 in 10 trials	.99
Sim:	4 " " "	1.04
Ca:	3 " " "	.99
MacN:	3 " " "	1.04
Mo:	2 in 8 trials	1.14
T.	2 " " "	1.16
V.	2 " " "	.92
Al:	2 in 10 trials	1.02
Ang:	1 in 7 trials	1.025
Mi:	1 in 8 trials	1.02
And:	1 in 10 trials	.88
Be:	1 " " "	1.10
Bu:	1 " " "	1.05
H.	1 " " "	1.02
Ma:	1 " " "	1.09

Subject	No: of "p" errors	Mean p-score.
MacL:	1 in 10 trials	.98
G.	0 in 8 trials	.97
A.R.	0 " " "	1.03
Su:	0 " " "	1.02
Coy:	0 in 10 trials	1.01
K.	0 " " "	.96
P.	0 " " "	.97
M.R.	0 " " "	1.02
Str:	0 " " "	1.10
To:	0 " " "	.96
W.	0 " " "	1.01

Wednesday and Friday Group.

Subject	No: of "p" errors	Mean p-score
Por:	6 in 10 trials	1.11
Bal:	5 " " "	1.18
N.	3 " " "	1.24
Pol:	3 " " "	.99
Bar:	2 " " "	1.11
R.	2 " " "	1.035
T.	1 in 8 trials	1.19
D.	1 in 10 trials	.97
H.F.	1 " " "	1.03
Mack:	1 " " "	1.04
MacP:	1 " " "	1.02
Sa:	1 " " "	.94

Subject	No: of "p" errors	Mean p-score
Sin:	1 in 10 trials	1.02
Wa:	1 " " "	.99
Bi:	0 in 10 trials	1.04
C.	0 " " "	1.055
M.F.	0 " " "	1.04
Ga:	0 " " "	1.25
Gr:	0 " " "	.91
Gu:	0 " " "	1.06
H.	0 " " "	1.025
Macd:	0 " " "	1.15
MacL:	0 " " "	1.10
Macn:	0 " " "	1.03
Sta:	0 " " "	1.045
We:	0 " " "	1.00

In the w Test, the only "perseverative" error in the whole experiment was made by Subject Gu:, in the Friday Group. Her mean perseveration scores in the w Test, for the three ways of scoring, are 1.01, 1.15 and 2.24 respectively, which are low.

h. Discussion of results.

Experiment II confirmed the main finding of Experiment I, that a perseveration test, of the alternation type, which consists of "short" units, gives a much higher "perseveration" score, than one, which consists of "long" units, but that the "perseveration" score/

score of the former is apt to correlate highly with the speed in the X part. It is difficult to estimade the value of this result. It was hoped, when Experiment I was planned, that tests, such as the Loops and Zig-zags Test and the Long and Short Lines Test, would form a new variety of perseveration test, that would be more satisfactory than previous ones. The results of Experiment I showed, and those of Experiment II confirmed, that the tests in question do not fulfil this hope. In addition to the fact, that the "perseveration" score in them depends largely upon the speed of the X part, even when they are scored by the "ratio method", there is no evidence, that they are measuring the same factor as other perseveration tests, and they are unsatisfactory in themselves, because subjects make so many errors in them. When Experiment II was planned, these facts were recognised, but it was hoped, that further study of tests composed of "short" units, would lead to better knowledge of the details of the movements, which take place in the performance of a perseveration test. The results of Experiments I and II may be said to make two contributions to such knowledge. In the first place, it has been shown that, while the speed, at which an individual repeats a very simple writing movement, can be altered a great deal according to how much effort he makes to work fast, the speed/

speed,at which he alternates two very simple writing movements, is not altered so much by voluntary effort to work quickly, and the speed, at which he writes more complex units is altered little or not at all. In the second place, to alternate two very simple writing movements causes much more loss of speed, in comparison with the rate of writing them continuously than to alternate two complex ones. These two facts might turn out to have some importance, if they were ever found to have bearing on any larger hypothesis, as to the part played by writing movements in the performance of perseveration tests. At present, however, they do not seem to have very much. The writer found it impossible to form any useful hypothesis on the subject of the movements which take place in perseveration tests, and abandoned this line of study.

One conclusion, which can be drawn from the results of Experiment II, is that there is little likelihood of the score in the ordinary kind of perseveration test, which consists of "long" units, being affected, to any serious degree, either by alterations in the instructions, which subjects are given with regard to speed, or by the degree of effort which they make to obey an instruction to work fast. It must of course be remembered, that the findings of Experiment II can only be assumed to hold good of normal adult subjects, with a friendly attitude to the test.

Obviously/

Obviously a subject, who deliberately tried to work slowly out of hostility, could reduce his speed in making ws or division signs as much as ever he liked, though in doing so he would of course not be working in his natural rhythm. It must also be remembered, that only the average scores for two groups were obtained in Experiment II. Although these are the same, or almost the same, whether the subjects are instructed to work at their natural rate or as fast as possible, there may be individuals, who would work at a different rate according to which of these two kinds of instructions was given. Clearly, the member of the Monday Group, who tried to write at a pace that would cause no subjective fatigue, eventually settled down to a speed that was distinctly less than his quickest.

The subjects' introspections suggest a number of lines of possible future research. The question, how far "perseverative" errors are due to absentmindedness, the part played by rhythm in the tests, the relation between the score and the extent, to which the subjects perceive the two items in the Y part as a unit, and the question, whether left and right movements are more easily confused than those in other directions, might all repay investigation. None of these lines of study has been pursued in the present research, because after the conclusion of Experiment II/

II, Dr Collins suggested a problem which seemed more important than any of them, namely, the problem whether the score in a motor test ever reaches constancy, however much practice is done in the test.

CHAPTER IV. EXPERIMENT III. THE DEGREE OF VARIATION IN THE PERSEVERATION SCORE OF THE w TEST WHEN IT IS REPEATED A LARGE NUMBER OF TIMES.

i. Introduction and statement of problem.

In Experiment II, the perseveration score of most of the subjects was by no means constant by the tenth trial, except in the case of the Loops Test, which is of uncertain value as a perseveration test, seeing that it is new, and is different in character from earlier tests, and has not been found to correlate significantly with any test composed of "long" units. In Experiment I, there was still considerable variation in the score of all the tests, even up to the fourteenth trial. As the Loops Test and the Long and Short Lines Test are of a new type, and the Division Signs Test correlates significantly with intelligence, the w Test is on general grounds the most satisfactory of the tests used, but it is the least reliable.

Other investigators have also found perseveration tests rather unreliable, and their procedure has also varied in the matter of whether they discarded the earlier trials of a test as a practice series or not. Pinard[30] discarded the first five trials of his tests as a practice series, but found the score still variable up to the tenth trial, although the reliability/

reliability increased as the testing went on. The first trial was, in his view, almost valueless.

Rangachar,[31] who also discarded the first five trials, says nothing about the degree of variation in score between single trials of his tests; he merely publishes high reliability coefficients obtained, presumably, from correlating the average scores of two groups of trials with one another. Other investigators have given tests only a small number of times. Lankes,[24] as already noted, repeated his tests from two to four times, and the reliability coefficients, which he obtained in this way, were in many cases rather low. Bernstein's[2] fairly high reliability coefficients were obtained by correlating the two halves of a test with one another, and would thus not reveal to any great extent the presence of a gradual, continuous change of score. Stephenson[40] gave the same test twice to his mental patients, and found a high degree of constancy in the score, except where the individual's emotional state had changed, but results obtained from psychotics are not necessarily true of normal people. In a recent experiment, Cattell[6] gave the w Test, the Triangles Test, twice in succession, and the Alphabets Test to fifty-two ten-year old children, and obtained reliability coefficients of .60, .38 and .59 respectively. In his first published work[5] on perseveration, the reliability of the Triangles/

Triangles Test is .41, and that of the Letter-writing Test is .52.

Lack of constancy in the score is a serious fault in any test which purports to measure temperament or character, as these do not change from day to day, though emotional mood may. It was therefore decided to give the w Test on each of fifty more or less successive days to each of a small group of subjects, to find whether the score was still variable by the fiftieth trial. The w Test was selected because it is a well-known perseveration test used by Stephenson[40] and Cattell[6], and because it admits of being scored both as a creative effort test and as an alternation test. The fact, that the score $\frac{X_1 + X_2}{Y}$ is not a pure measure of the subject's difficulty in alternation, when the units, of which X_1 and X_2 are composed, are unequal in difficulty, was not known when Experiment III was planned.

ii. Subjects.

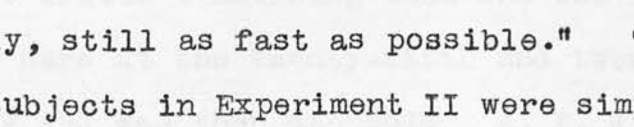
There were eighteen subjects; a larger number did not seem necessary, as the scores of each subject were to be compared only with one another, and not with those of other subjects. Subjects A to D were lecturers or demonstrators in the Psychology Department of Edinburgh University; E and F were students in the Advanced Psychology Class; and G to Q inclusive were/

were students in the Ordinary Psychology Class. R. was an elderly lady with little knowledge of Psychology. G, J, K, L, O, P and Q had been subjects in Experiment II, and D had had considerable previous practice at the w Test, but this did not seem to be a drawback, as it only increased the total amount of practice, which they would have had by the end of the experiment.

iii. Procedure.

The test was given once on each of fifty more or less successive days, during April, May and June 1935. In the case of most of the subjects, there was an interval of one or two days at weekends, on which the test was not done, and a few intervals of three days occurred. It would have been difficult to obtain subjects who were willing to do the test on fifty absolutely successive days, and it was also considered that a test, of which the score is affected by the length of time, which has elapsed since its last application, is too delicate an instrument to be of practical use. Except in the case of Subject C, whose results were discarded because of the irregularity of her times, the test was done at approximately the same hour at least on the majority of the days. The number of trials done by different subjects ranged from forty-seven to fifty-one. The tests were timed/

timed by the writer, except where it is otherwise stated; in those cases, in which the subject was allowed to be timed by someone else, he had the importance of accurate timing strongly impressed on him first. The length of the test periods and rest pauses was as in Experiment II. Those who had not done the test before were given approximately the following instructions, after a preliminary explanation of the purpose of the test: "In the first part of the test you make ordinary ws as fast as possible. (A few were written by E. as an example). They must have the two main parts and the hook. They may have an extra stroke at the beginning, but they need not. Then you have thirty seconds rest. In the second part you make reversed ws , still as fast as possible (A few were written as an example). Do one or two now to make sure that you know what is meant. In the third part you make the ordinary and the reversed w alternately, still as fast as possible." Those who had been subjects in Experiment II were simply told that the test was the w Test; if they had belonged to the "Monday Group" they were told that it was to be done as fast as possible now. All the subjects were shown a number of sample ws , as follows:



They/

They were told that the first two were more or less ideal ones and the rest in the first line just good enough to pass; those in the second line were not good enough. This procedure, suggested by Cattell, was intended to prevent subjects from sacrificing quality too much for the sake of speed. On the second day, they were told that a w in which the hook was the same size as the two main parts was also an error, as one subject had made one like this; they were shown a sample of it. At first they were perhaps not reminded sufficiently often to work as fast as possible, but from April 19th onwards, the fourth trial in most cases, they were always reminded before X_1, and sometimes again before one or both of the other parts. The majority were told not to count their score as it was felt that this incentive might cause irregularities; by an oversight E and F were not told this and E counted hers till the twenty-eighth trial, without the writer's noticing that she was doing so. F counted hers at the twenty-fifth and twenty-sixth trials only and was then stopped. A, I, J and K disobeyed the instruction a certain number of times. Perhaps it is unwise to forbid subjects to count their score, as the restriction seems to prove irksome to many, and as it is sometimes possible, as A and J found, to count silently while actually doing the test. Also it seems probable, from facts such as the unusually high speeds, reached once or twice by D near the/

the end of the period under unusual conditions, and the decrease in the speed in Y on the part of subjects G and N during the later trials, that the physiological limit of speed was not being reached. It might be more nearly approached if subjects counted their score. Against this is the fact that in Experiment II, those subjects who were told to work at their natural pace reached, on the average, as high a speed as those who were told to work fast; also E's speed in this experiment did not decrease when she stopped counting. The test was done, in most cases, on large lined quarto paper with a margin of slightly over an inch. C frequently used a smaller size. K did so two or three times, and F once.

vi. Scoring.

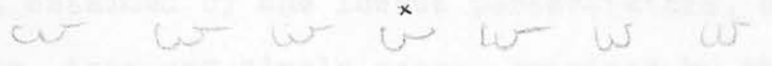
As in Experiment II, the tests were scored by the three methods $\frac{X_1 + X_2}{Y}$, $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$. At first, an attempt was made to count as an error any w less good than those shown on the sample sheet - even this is a slightly more lenient method of scoring than in Experiment II - and subjects were criticised if they made many errors. This, however, was causing Subject I to have a great number of errors and consequently a very irregular score, and it seemed likely that the constant criticism would discourage him, so a more lenient standard was adopted, by which, in addition to those shown as correct on the sample sheet, any w with a single, square-bottomed main part, as this/

this: , was counted as correct, or any with a single, round-bottomed main part, in which there was the slightest evidence that the pencil had paused in the centre, or even one in which there was not, if the general proportions suggested a w rather than a v. Thus would be regarded as correct but not . The scoring of doubtful cases erred on the side of leniency. I, however, still had so many errors that his score became meaningless from the sixteenth trial. Finally, the tests were re-scored counting all the ws made as correct, except "perseverative errors" and "interference errors", and the results of both these methods of scoring will be given. No subject was criticised from April 26th onwards, and from May 6th errors were marked on the paper only by dots and not crossed out, so that subjects should be less likely to notice them. (Four trials were usually done on one double sheet). I's were not always marked even in this way.

In the two previous experiments the writer felt a strong tendency to score bad writers more leniently than good writers, but resisted it to the best of his ability. In this experiment she yielded to it to a certain extent, because an error made by a good writer is probably as a rule a genuine lapse, due to some such cause as fatigue or wandering of attention, whereas one made by a bad writer is often due simply to the curtailment of movements in order to increase speed. This can be seen if the two following examples are/

are compared:

Tracing of part of Q's work in X_1 at the 27th trial:



Tracing of part of N's work in X_1 at the 27th trial:

The w marked on the first was counted as an error, for Q had obviously missed out one of her two usual rounded main parts; that marked in the second was not, for N appeared simply to have abbreviated her usual movement.

v. Results.

a. General Result.

In dealing with the results, it was necessary first to decide, how great a degree of variability in the score was sufficient to invalidate the test as a measure of temperament. It seemed that, when all those trials had been eliminated, in which the perseveration score appeared to be affected by practice effect or any disturbing influence, it should be possible, by means of any one of the remaining scores, to differentiate one or two, at least, of the lowest and highest perseverators in the group from those subjects, whose perseveration scores were near the average for the group. In other words, when the subjects/

subjects had been arranged in the order of the size of their mean perseveration scores, the highest single scores, obtained by the lowest perseverators, should be lower, than any single score, obtained by those nearest the mean for the group, and the highest single scores, obtained by those nearest the middle of the group, should be lower, than any single score, obtained by the highest perseverators. If this were so, it would prove that it was possible, by means of a score obtained from a single trial of the w Test, done after sufficient preliminary practice, to differentiate very high and very low perseverators from other individuals with a high degree of reliability.

It was first, however, necessary to discard any trials in which the score was invalidated in any way. The results of Subjects C and R were discarded altogether, those of C because she had done the test at very irregular times, and those of R because she had done it under less rigid conditions than the other subjects. The results of these two subjects will be given in detail along with those of the others, because they are of some interest - C's scores are not as a matter of fact more variable than those of many of the other subjects, and R's are interesting because of her age - but no conclusions as to the variability of the score have been based on them. Next, the first fifteen trials were discarded, as practice effect/

effect seemed to be continuing as far as this. As a matter of fact, it continued much further in a few subjects, but it seemed unreasonable to regard more than fifteen trials as a practice series. Any trials, in which there had been any fault in procedure, were discarded, as was a single trial, done by many of the subjects with the pressure pencil, in connection with a subsidiary experiment* Next, all those trials were noted in which anything had occurred which might possibly upset the result; such disturbing influences included fatigue, ill-health or depression on the part of the subject, distraction by noise, the fact of the subject's mind wandering pronouncedly during the test, physical impediments, such as cold hands, or roughness of the surface under the paper, on which the subject wrote, accidents such as the subject's pencil breaking, and the fact of the test being done at an unusual time, or after an interval of one or more days on which there had been no testing. If the perseveration score, by any of the three methods of scoring, for a trial in which any of these factors was present, was higher or lower than any other score from the sixteenth to the last inclusive, or if the speed in any of the three parts was distinctly lowered, that trial was discarded. If/

* See Chapter VII.

If this was not the case, the trial was retained, as it was assumed, that the factor in question had not actually upset the score to more than a very slight extent at most. In other words, the range of the scores included in each subject's final result is determined by trials in which no disturbing influence of any kind was present. The number of trials finally retained ranged from twenty-seven to thirty-four, in the case of different subjects. The method of scoring used was that in which all the ws made were counted as correct, except "perseverative" errors and "interference" errors; this made it possible to include Subject I and made Subject A's scores pronouncedly less variable.

Tables will now be given showing the distribution of each subject's scores, according to the three ways of scoring, for the trials finally retained. In the case of each way of scoring, the subjects will be arranged in the order of size of their mean perseveration score, which will be given.

Distribution of subjects' scores for scoring $\frac{X_1 + X_2}{Y}$

Subject.	K	M	H	N	A	B	J	F	G	Q	E	L	D	O	I	P
Mean p-score	1.08	1.08	1.07	1.03	1.02	1.00	1.00	.99	.99	.98	.97	.97	.96	.96	.94	.93
No: of trials retained.	31	34	32	33	31	30	33	32	31	32	30	27	27	32	27	31
Distribution: Class interval.																
1.24 - 6		1														
1.21 - 3		1														
1.18 - 20	1	1			1											
1.15 - 7	3	1	2		0											
1.12 - 4	1	1	7	1	2											
1.09 - 11	12	7	5	4	2						1					
1.06 - 8	2	11	3	6	5				3	1	1					
1.03 - 5	7	6	4	8	5	3	4		3	0	3	1	1			
1.00 - 2	4	5	9	6	6	14	14	13	8	12	3	5	6	7	3	3
.97 - 9	1		1	4	3	9	12	17	8	11	5	10	7	8	5	3
.94 - 6			1	4	4	4	3	2	4	4	9	7	6	9	4	9
.91 - 3					3				2	4	5	4	4	8	8	10
.88 - 90									3		2		3		6	3
.85 - 7											1				1	2
.82 - 4																1

Distribution of subjects' scores for scoring $\frac{X_1}{X_2}$

Subject.	K	A	H	L	M	O	Q	F	E	J	N	B	D	G	I	P
Mean p-score	1.42	1.40	1.38	1.32	1.31	1.27	1.25	1.24	1.23	1.21	1.19	1.15	1.09	1.08	1.03	.98
No: of trials retained.	31	31	32	27	34	32	32	32	30	33	33	30	27	31	27	31
Distribution: Class interval.																
1.65 - 9			1													
1.60 - 4			0													
1.55- 9	3	1	2													
1.50 - 4	4	4	3													
1.45 - 9	3	6	3	1	2				2							
1.40 - 4	5	5	3	0	5				2							
1.35 - 9	8	7	5	6	3	2	1	3	1							
1.30 - 4	7	2	7	13	10	8	2	1	2							
1.25 - 9	1	3	5	5	5	10	13	7	2	1	2	2		1		
1.20 - 4		2	3	2	5	9	14	13	10	23	12	3		1	1	
1.15 - 9		1			4	3	2	8	7	9	11	8	6	1	4	
1.10 - 4									1		6	14	6	11	2	
1.05 - 9									3		2	3	9	9	4	2
1.00 - 4													5	6	6	13
.95 - 9													1	2	5	7
.90 - 4															4	6
.85 - 9															1	2
.80 - 4																1

Distribution of subjects' scores for scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$

Subject.	K	H	A	M	L	O	Q	F	N	E	J	B	D	G	I	P
Mean p-score	2.67	2.62	2.59	2.54	2.43	2.34	2.34	2.33	2.31	2.29	2.29	2.22	2.10	2.10	1.99	1.90
No: of trials retained.	31	32	31	34	27	32	32	32	33	30	33	30	27	31	27	31
Distribution: Class interval.																
2.90 - 4	1	1														
2.85 - 9	5	3	1													
2.80 - 4	1	1	0	2												
2.75 - 9	1	2	6	2												
2.70 - 4	6	0	4	2												
2.65 - 9	3	7	3	3						1						
2.60 - 4	4	6	3	1	1					0						
2.55 - 9	3	2	4	4	2				1	3						
2.50 - 4	5	2	1	5	3		1	1	0	0						
2.45 - 9	0	3	3	4	2	4	2	3	0	1						
2.40 - 4	1	2	1	4	7	5	2	1	4	0		1				
2.35 - 9	1	2	0	3	8	7	9	7	6	4	2	1				
2.30 - 4		1	3	3	3	9	7	9	9	2	15	3		1	1	
2.25 - 9			0	1	1	4	8	7	6	7	14	3	1	2	2	
2.20 - 4			2			1	3	4	3	3	2	7	4	2	0	
2.15 - 9						2			1	5		11	1	6	3	
2.10 - 4									3	2		4	7	5	2	
2.05 - 9										2			6	8	2	4
2.00 - 4													4	1	2	1
1.95 - 9													3	2	2	7
1.90 - 4														4	2	5
1.85 - 9															7	4
1.80 - 4															1	3
1.75 - 9															3	6
1.70 - 4																0
1.65 - 9																1

It is clear that the scores do not differentiate low, moderate and high perseverators at all well. For the scoring $\frac{X_1 + X_2}{Y}$, the mean score for the group is 1.00. Subjects B and J have mean scores which are the same as the mean for the group. Subject P is, on the average, the lowest perseverator; fifteen of his scores are in the same class intervals as twenty-nine of J's, and he is no more clearly differentiated from B. Twelve of the scores of I, the second lowest perseverator, fall in the same three class intervals. K and M, the two highest perseverators, have each five scores as low as, or lower than, the highest scores of P and I. It is evident that a single score, when the test is scored by the method $\frac{X_1 + X_2}{Y}$, is of no use for differentiating high, medium and low perseverators from each other.

The situation is better when the other two methods of scoring are used, but is still not wholly satisfactory. For the scoring $\frac{X_1}{X_2}$, the mean score of the group is 1.22; thus subjects E and J are nearest the average for the group. P is again the lowest; two of his scores fall in the same class interval as three of E's, but he is completely differentiated from J, and from all the subjects, whose mean scores are above E's. I, the second lowest perseverator is not well differentiated from the moderate ones. As all his scores over 1.10 were made before the/

the twenty-fifth trial, he would have been well differentiated, if the first twenty-five trials had been discarded, but this would really have been rather a long practice series. The scores of the high perseverators overlap those of the moderate ones considerably. K indeed has only one score as low as any of J's, but twenty-four of his scores fall in the same class intervals as nine of E's. His lowest score is as low as the highest score obtained by G, the fourth lowest perseverator. A is not completely differentiated from any other subject except P. H and L are completely differentiated only from P and D. One might perhaps say with a fair degree of confidence, that if a subject has done fifteen trials at the W Test as a practice series, and his score $\frac{X_1}{X_2}$ for the sixteenth trial is lower than 1.10, that subject is a low perseverator. It is doubtful if the test can be relied upon to differentiate high perseverators from moderate ones.

For the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, the mean score of the group is 2.32. Thus F and N are nearest the average for the group. P is perfectly differentiated from these, and also from Subjects J and B, who have mean scores of 2.29 and 2.22 respectively. Four of his scores fall in the same class interval as two of E's, whose mean score is 2.29. I is again not well differentiated from the moderate perseverators, though/

though again he would be, if the trials up to the twenty-fifth were discarded. The high perseverators are not well differentiated; for example, seven of K's scores are as low as twelve of F's. A subject, who obtained a score of less than 2.10 at the sixteenth trial, by this method of scoring, might perhaps be fairly safely regarded as a low perseverator.

It seemed that a more constant score might be obtained, if the average score for groups of five successive trials were used. To do this would smooth out those changes of score, which consisted of random fluctuations about an average, towards which the scores were tending, although continuous changes over longer periods would still remain. If the score obtained from a motor test of perseveration, were ever proved to be of great value for the measurement of temperament or character, it would not be an impossibly laborious procedure, to give a subject twenty successive trials at such a test, and to take the average score for the last five as indicating the strength of the perseverative tendency.

Tables will now be given, showing both the actual mean scores of the subjects for groups of five successive trials, and the distribution of these mean scores.

Scoring $\frac{X_1 + X_2}{Y}$ Mean scores of subjects for groups of five successive trials.

Subject.	K	M	H	N	A	B	J	F	G	Q	E	L	D	O	I	P
Mean score for all trials from the 16th to the last.	1.08	1.08	1.07	1.03	1.02	1.00	1.00	.99	.99	.98	.97	.97	.96	.96	.94	.93
Mean score for trials:																
16 - 20	1.08	1.08	1.015	1.00	1.08	1.02	1.01	.99	.98	.98	.99	.99	.95	.99	.985	.94
21 - 5	1.10	1.04	1.07	1.00	1.02	1.00	1.01	.99	1.00	.97	.95	.96	.99	.94	.97	.91
26 - 30	1.05	1.11	1.01	1.05	1.04	.985	.98	.99	.96	.98	.97	.97	.965	.98	.96	.89
31 - 5	1.12	1.08	1.09	1.04	1.07	1.00	1.00	.99	.94	.99	.94	.985	.955	.96	.92	.93
36 - 40	1.07	1.10	1.04	1.02	1.04	.97	.99	1.01	.99	1.00	.99	.98	.96	.99	.90	.94
41 - 5	1.05	1.05	1.12	1.03	.94	1.00	.995	.99	1.00	.98	1.01	.96	.965	.93	.90	.975
46 - last	1.07	1.09	1.11	1.08	.95	.995	.99	.91	1.02	.98	.97	.955	.94	.96	.89	.98

(Owing to the discarding of some trials, some of the averages here and there are derived from less than five trials.)

Scoring $\frac{X_1 + X_2}{Y}$ Distribution of mean scores of subjects for groups of five successive trials.

Subject.	K	M	H	N	A	B	J	F	G	Q	E	L	D	O	I	P
Mean score for all trials from the 16th to the last.	1.08	1.08	1.07	1.03	1.02	1.00	1.00	.99	.99	.98	.97	.97	.96	.96	.94	.93
Distribution: class interval:-																
1.12 - 4	1		2													
1.09 - 11	1	3	1													
1.06 - 8	3	2	1	1	2											
1.03 - 5	2	2	1	3	2											
1.00 - 2			2	3	1	4	3	1	3	1	1					
.97 - 9					0	3	4	6	2	6	4	4	1	3	2	2
.94 - 6					2				2		2	3	6	3	1	2
.91 - 3														1	1	2
.88 - 90															3	1

Scoring $\frac{X_1}{X_2}$ Mean scores of subjects for groups of five successive trials.

Subject.	K	A	H	L	M	O	Q	F	E	J	N	B	D	G	I	P
Mean score for all trials from the 16th to the last.	1.42	1.40	1.38	1.32	1.31	1.27	1.25	1.24	1.23	1.21	1.19	1.15	1.09	1.08	1.03	.98
Mean score for trials:																
16 - 20	1.38	1.45	1.31	1.38	1.33	1.23	1.26	1.345	1.29	1.19	1.21	1.21	1.12	1.04	1.17	.90
21 - 5	1.34	1.43	1.34	1.30	1.25	1.24	1.28	1.26	1.35	1.22	1.18	1.15	1.085	1.105	1.11	.96
26 - 30	1.40	1.42	1.48	1.26	1.31	1.22	1.24	1.23	1.24	1.20	1.24	1.185	1.05	1.03	1.015	.96
31 - 5	1.44	1.40	1.38	1.32	1.30	1.28	1.25	1.22	1.175	1.21	1.21	1.14	1.085	1.11	.99	.99
36 - 40	1.51	1.43	1.40	1.32	1.35	1.295	1.25	1.20	1.185	1.21	1.11	1.13	1.16	1.02	.97	1.02
41 - 5	1.44	1.35	1.39	1.33	1.30	1.32	1.23	1.22	1.23	1.20	1.175	1.12	1.09	1.12	.94	1.02
46 - last	1.36	1.22	1.355	1.32	1.33	1.30	1.22	1.19	1.16	1.21	1.185	1.15	1.09	1.11	1.01	1.06

(Owing to the discarding of some trials, some averages here and there are derived from less than five trials)

Scoring $\frac{X_1}{X_2}$ Distributions of mean scores of subjects for groups of five successive trials.

Subject.	K	A	H	L	M	O	Q	F	E	J	N	B	D	G	I	P
Mean score for all trials from the 16th to the last.	1.42	1.40	1.38	1.32	1.31	1.27	1.25	1.24	1.23	1.21	1.19	1.15	1.09	1.08	1.03	.98
Distribution: class interval:-																
1.50 - 4	1															
1.45 - 9	0	1	1													
1.40 - 4	3	4	1													
1.35 - 9	2	1	3	1	1				1							
1.30 - 4	1	0	2	5	5	2		1	0							
1.25 - 9		0		1	1	2	4	1	1							
1.20 - 4		1				3	3	4	2	6	3	1				
1.15 - 9								3	3	1	3	3	1		1	
1.10 - 4											1	3	1	4	1	
1.05 - 9													5	0	0	1
1.00 - 4														3	2	2
.95 - 9															2	3
.90 - 4															1	1

Scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ Mean scores of subjects for groups of five successive trials.

Subject.	K	H	A	M	L	O	Q	F	N	E	J	B	D	G	I	P
Mean score for all trials from the 16th to the last.	2.67	2.62	2.59	2.54	2.43	2.34	2.34	2.33	2.31	2.29	2.29	2.22	2.10	2.10	1.99	1.90
Mean score for trials:																
16 - 20	2.63	2.46	2.73	2.57	2.53	2.32	2.35	2.48	2.31	2.40	2.30	2.33	2.12	2.04	2.24	1.78
21 - 5	2.605	2.56	2.63	2.41	2.38	2.28	2.36	2.36	2.265	2.38	2.30	2.21	2.115	2.15	2.13	1.85
26 - 30	2.58	2.685	2.64	2.57	2.34	2.29	2.33	2.32	2.39	2.31	2.27	2.25	2.035	2.01	1.985	1.83
31 - 5	2.76	2.64	2.64	2.51	2.44	2.36	2.35	2.32	2.34	2.19	2.31	2.20	2.08	2.10	1.91	1.92
36 - 40	2.80	2.61	2.65	2.60	2.42	2.41	2.36	2.27	2.19	2.26	2.29	2.15	2.19	2.03	1.85	1.97
41 - 5	2.68	2.71	2.42	2.50	2.43	2.38	2.31	2.31	2.275	2.34	2.29	2.17	2.09	2.17	1.84	2.005
46 - last	2.51	2.63	2.26	2.58	2.41	2.39	2.30	2.26	2.355	2.20	2.30	2.21	2.07	2.20	1.91	2.07

(Owing to the discarding of some trials, some averages here and there are derived from less than five trials.)

Scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ Distributions of mean scores of subjects for groups of successive five trials.

Subject	K	H	A	M	L	O	Q	F	N	E	J	B	D	G	I	P
Mean score for all trials from the 16th to the last.	2.67	2.62	2.59	2.54	2.43	2.34	2.34	2.33	2.31	2.29	2.29	2.22	2.10	2.10	1.99	1.90
Distribution: class interval:																
2.80 - 4	1															
2.75 - 9	1															
2.70 - 4	0	1	1													
2.65 - 9	1	1	1													
2.60 - 4	2	3	3	1												
2.55 - 9	1	1	0	3												
2.50 - 4	1	0	0	2	1											
2.45 - 9		1	0	0	0			1								
2.40 - 4			1	1	4	1		0		1						
2.35 - 9			0		1	3	4	1	2	1						
2.30 - 4			0		1	1	3	3	2	2	4	1				
2.25 - 9			1			2		2	2	1	3	1				
2.20 - 4									0	1		3		1	1	
2.15 - 9									1	1		2	1	2	0	
2.10 - 4													2	1	1	
2.05 - 9													3	0	0	1
2.00 - 4													1	3	0	1
1.95 - 9															1	1
1.90 - 4															2	1
1.85 - 9															1	1
1.80 - 4															1	1
1.75 - 9																1

The subjects are certainly better differentiated from each other, when the mean scores for groups of five successive trials are used. For the scoring $\frac{X_1 + X_2}{Y}$, the four highest perseverators have no score below 1.00, and the five lowest have no score above 1.00. The two highest perseverators are completely differentiated from B and J , who have the same mean score as the group, but the lowest perseverators are not completely differentiated from anyone lower than N, the fourth highest.

For the scoring $\frac{X_1}{X_2}$, the high perseverators are not well differentiated from the moderate ones, owing to the great variability of the scores of A and E. A is not completely differentiated from anyone higher than D, the fourth lowest perseverator. The low perseverators are fairly well differentiated. I and D have each one score in the same class interval as several of those of the moderate ones, but P and G are completely differentiated.

For the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, K, the highest perseverator, is perfectly differentiated not only from F and N, who are nearest the average for the group, but also from O and Q, who are a little above it. H, the second highest perseverator, has one score in the same class interval as one of F's. A, the third highest, is not at all well differentiated from the moderate ones. P, the lowest perseverator, is completely/

completely differentiated from all the subjects from B upwards, but the scores of I, G and D, the three next lowest, overlap with those of N.

The scores can be considered in another way. If, for the scoring $\frac{X_1 + X_2}{Y}$, we regard a score of 1.07 or over as indicating extremely high perseveration, a score of 1.00 to 1.06 as indicating moderately high perseveration, a score of .96 to .99 as indicating moderately low perseveration, and a score of .95 or under as indicating extremely low perseveration, then subjects K, M and H would appear to be only moderately high perseverators, were their mean scores for certain groups of five trials to be considered alone, although they are extremely high ones when the average of all the trials is considered. A, who is a moderately high perseverator on the average, would appear as an extremely high one, were the mean score for trials 31 to 35 to be considered alone, and an extremely low one if the last ten trials alone were considered. I and P, who are on the average extremely low perseverators, would appear to be only moderately low ones, according to their mean scores for certain groups of five trials. The moderately high perseverators would appear as moderately low ones, according to certain of their scores, and the moderately low ones, with the exception of L, would sometimes appear as moderately high.

For/

For the scoring $\frac{X_1}{X_2}$, scores above 1.40 might perhaps be taken as indicating extremely high perseveration, and scores below 1.00 as indicating extremely low perseveration. The dividing line between moderately high and moderately low perseveration must be taken as the mean score, 1.22. The two extremely high perseverators both sometimes appear as only moderately high. Of the moderately high ones, H appears sometimes as extremely high and F and E as moderately low. Of the moderately low ones, J, N and B appear sometimes as moderately high. P never appears as anything but extremely low.

For the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, the score 2.60 may be taken as the dividing line between moderately and extremely high perseveration, the score 2.32 as that between moderately high and moderately low perseveration, and the score 2.00 as that between moderately and extremely low perseveration. Again the two extremely high perseverators appear sometimes as only moderately high. A, who is on the average moderately high, appears as extremely high up to the fortieth trial, and moderately low during the last five. M, who is on the average a moderately high perseverator, appears once as extremely high, while F and O appear sometimes as moderately low. Of the moderately low perseverators, N, E and B appear sometimes as moderately high. I and P are both on the average extremely/

extremely low perseverators; both appear sometimes as only moderately low.

It thus appears that, when the mean score for a group of five successive trials is taken as indicating the degree of a subject's perseveration, there is little likelihood that an extremely low perseverator will be mistaken for an extremely high one, or vice versa, but considerable possibility, that extremely low and high perseverators will be confused with moderate ones. Subjects are best differentiated by the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, and least well by the scoring $\frac{X_1 + X_2}{Y}$.

A fact, which makes one further doubt the ability of the test to differentiate subjects reliably, and which is more easily discerned, when the mean scores for groups of five successive trials are considered, is that some of the changes which took place were gradual, continuous ones. For example, the speed of Subject A in X_2 and Y increased pronouncedly near the end of the period of testing, because he found a new and better way of forming the reversed w. Both for the scoring $\frac{X_1}{X_2}$ and for the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, his six lowest scores all occur after the thirty-ninth trial, as do his seven lowest scores for the scoring $\frac{X_1 + X_2}{Y}$. It is extremely probable that, if the testing had continued longer, he would have gone on having low scores, so that, if the mean score for, say, the trials/

trials from the sixteenth to the eightieth had been obtained for all the subjects, instead of that for the trials from the sixteenth to the fiftieth, he would have appeared as, on the average, a moderate perseverator instead of a high one. Subject K reported, at trials 41 and 42, that the reversed ws seemed easier than before, and, while there was no marked alteration in his scores up to the end of the period of testing, there was a tendency towards an increase in the speed of the X_2 part, which might have become pronounced, had the testing continued longer. The truth is, that fifty trials are not sufficient completely to eliminate practice effect. Subject I, who formed his ws very carelessly, was still improving in speed at a rapid rate, in all three parts of the test, at the very end of the period. There were signs that he was approaching his limit, but he had certainly not reached it. If the tendency of his perseveration score to decrease ceases at about the twenty-fifth trial, when the test is scored by the methods $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, that is only because from there onwards the speed of X_1 and X_2 increased at the same rate, whereas earlier the speed of X_2 increased at a rapider rate than that of X_1. Subject H had a series of high scores towards the end of the period, when the scoring $\frac{X_1 + X_2}{Y}$ was used, because her speed in X_1 and X_2 improved, while her/

her speed in Y remained approximately constant. That is why the distribution of her scores for single trials has two peaks. In short, it is impossible to be certain, that an improvement in speed, in one or another part of the test, will not cause a considerable alteration in a subject's scores, even after a very large amount of preliminary practice. The scores of high perseverators, who have difficulty with the reversed w, are particularly likely to decrease, even after many trials have been done, owing to the discovery, on the part of the subject, of an easier method of forming the reversed w.

In view of the fact, that Cattell[5,6,7] and Stephenson[40 and 41] take the score obtained in the first or second trial of a perseveration test, as the true indication of a subject's perseveration, while Pinard[30] took the mean score for the trials from the sixth to the tenth inclusive, and Rangachar[31] took that for the sixth to the twenty-fifth inclusive, it seemed worth while to compare with each other, and also with the mean score for the trials from the sixteenth to the last, the scores obtained at these stages of the experiment, by the eight subjects, who had had no previous practice of the test. Tables will therefore be given, showing the score of these eight subjects for the first and second trial, and their mean score for the trials/

trials from the sixth to the tenth, the sixth to the twenty-fifth, and the sixteenth to the last. Their rank order will also be given at these stages of the experiment.

Scoring $\frac{X_1 + X_2}{Y}$ Scores and rank order at different stages of Experiment III of those subjects who had had no previous practice in the w Test.

Subject	Trial 1		Trial 2		Trials 6-10		Trials 6-25		Trials 16-last	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
A	.96	6½	1.04	4	1.08	1	1.05	.2	1.02	4
B	1.30	1	1.11	2	1.05	3	1.03	3½	1.00	5
E	.94	8	.97	7	.98	8	.975	8	.97	7
F	1.00	5	.98	6	1.02	4	1.01	5	.99	6
H	.96	6½	.80	8	1.00	5½	1.03	3½	1.07	2
I	1.17	2	1.07	3	1.00	5½	.99	7½	.94	8
M	1.07	4	1.15	1	1.07	2	1.07	1	1.08	1
N	1.12	3	1.03	5	.99	7	.99	7½	1.03	3

Scoring $\frac{X_1}{X_2}$ Scores and rank order at different stages of Experiment III of those subjects who had had no previous practice in the w Test.

Subject	Trial 1		Trial 2		Trials 6-10		Trials 6-25		Trials 16-last.	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
A	1.70	3	1.73	2	1.56	1	1.49	1	1.40	1
B	1.61	5	1.41	6	1.375	4	1.26	6	1.15	7
E	1.67	4	1.32	7	1.28	$6\frac{1}{2}$	1.30	5	1.23	5
F	2.19	1	1.76	1	1.52	2	1.39	2	1.24	4
H	1.27	8	1.43	$4\frac{1}{2}$	1.40	3	1.33	4	1.38	2
I	1.33	6	1.43	$4\frac{1}{2}$	1.28	$6\frac{1}{2}$	1.19	$7\frac{1}{2}$	1.03	8
M	1.32	7	1.30	8	1.34	5	1.34	3	1.31	3
N	1.71	2	1.52	3	1.19	8	1.19	$7\frac{1}{2}$	1.19	6

Scoring $\frac{X}{X2} + \frac{2\,X_1}{Y}$ Scores and rank order at different stages of Experiment III of those subjects who had had no previous practice in the w Test.

Subject	Trial 1		Trial 2		Trials 6-10		Trials 6-25		Trials 16-last.	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
A	2.91	4	3.05	1	2.875	1	2.74	1	2.59	2
B	3.22	2	2.71	4	2.59	3	2.40	5	2.22	7
E	2.85	5	2.42	7	2.38	7	2.39	6	2.29	6
F	3.56	1	3.01	2	2.74	2	2.57	2	2.33	4
H	2.35	8	2.37	8	2.58	4	2.50	4	2.62	1
I	2.67	6	2.69	5	2.41	6	2.26	8	1.99	8
M	2.54	7	2.60	6	2.56	5	2.56	3	2.54	3
N	3.12	3	2.76	3	2.26	8	2.27	7	2.31	5

It is clear, that both the actual scores and the rank order alter considerably, when the scores for the two earliest trials are compared with the mean scores for groups of later ones. The scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ decrease pronouncedly in most cases in the earlier part of the testing, and the score $\frac{X_1 + X_2}{Y}$ shows apparently random fluctuations. The rank order alters most in the case of the score $\frac{X_1 + X_2}{Y}$.

In other words, it seems to be the case that not only does the perseveration score never, after any amount of repetition, become reliable enough to differentiate high, medium and low perseverators altogether satisfactorily, but the very early scores are widely different from the score obtained by finding the average of a number of later trials. It is not possible to obtain from a group of eight subjects a correlation coefficient, that would have any value, between the score for the first or second trial, on the one hand, and the average score for the trials from the sixth to the tenth, the sixth to the twenty-fifth, or the sixteenth to the last, on the other hand, but it seems very unlikely, from inspection of these results, that were a larger number of subjects used, such a correlation coefficient would be as high as a reliability coefficient should be, and it is possible that it might be zero. In other words, it is possible, that the perseveration scores used by Cattell and Stephenson/

Stephenson are not measuring the same factor or factors at all, as those used by Pinard and Rangachar, and it is certain that the scores used by these two pairs of investigators are not equally good measures of perseveration. Throughout the present investigation it has been assumed, that the score which is obtained, after practice effect has been eliminated, is the true perseveration score. The possibility, that the initial score is the true one, will be discussed in the last chapter. The result just given establishes that they cannot both be the true one.

b. Relation between the perseveration score and the form of the reversed w.

The mean perseveration score, for the trials from the sixteenth to the last, appears to depend very largely upon the form taken by the reversed w.

The commonest form of reversed w is one which is rounded and similar to the ordinary one, but tilted in a backhand direction, sometimes only a little, sometimes so much that it becomes almost a figure 3 with a hook at the top. Apparently the tilting makes the reversed w easier to write, possibly because, as Saudek[37] points out, downwards movements in handwriting are made relatively more quickly than movements in other directions. The present writer tilted her reversed/

reversed ws considerably during most of the test, but finds it rather hard to say why; she felt them, when they were most tilted, simply as wavy lines; even when she tries hard to make them horizontal; she finds it practically impossible, to make the right hand main part of the w come down as low as the left hand one. The psychotic subject, of whose work Stephenson gives illustrations, made her reversed ws tilted. A much smaller number of subjects make the reversed w upright like the ordinary one, but angular in form instead of rounded. A, who does this, was asked at the end of the experiment why he did so, and said he thought it was because it meant simply moving the fingers up and down, while the whole hand was moved from right to left, which was easier than reversing a curved movement. The fact, pointed out by Saudek[37], that the formation of an angle in writing involves a complete stoppage of the writing movement, for a fraction of a second, suggests that subjects, who make an angular reversed w, will have a high perseveration score, by the methods of scoring $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, and on the whole this is actually the case. Two subjects in the present experiment tilted their reversed ws in a forehand direction, one making them rounded and the other making them angular, while Subject I's reversed ws had deteriorated, by the twenty-first trial, into little lines, which either had one/

one angle in the middle, or less often, were wavy; up to the twenty-first trial they were rather variable.

The table, which follows, shows the mean perseveration score for the trials from the sixteenth to the last, by the method of scoring $\frac{X_1}{X_2}$, the subjects being arranged in order of the size of their score, together with a short description of the form of the reversed w. This method of scoring is chosen, because it is a pure measure of difficulty in forming the reversed w , apart from difficulty in alternation.

Subject.	Mean score $\frac{X_1}{X_2}$	Description of reversed w.
K	1.42	Angular; upright or sometimes slightly tilted in a backhand direction.
A	1.40	Angular; upright.
H	1.38	Usually angular and tilted in a forehand direction, but rather variable.
L	1.32	Rounded; slightly tilted in a backhand direction.
M	1.31	Rounded; pronouncedly tilted in a forehand direction.
O	1.27	Rounded; pronouncedly tilted in a backhand direction.
Q	1.25	Rounded; slightly tilted in a backhand direction.
F	1.24	Angular; upright.
E	1.23	Rounded; pronouncedly tilted in a backhand direction.
J	1.21	Rounded; pronouncedly tilted in a backhand direction.
N	1.19	Rounded; pronouncedly tilted in a backhand direction.
B	1.15	Rounded; slightly tilted in a backhand direction.
D	1.09	Rounded; pronouncedly tilted in a backhand direction.
G	1.08	Rounded; pronouncedly tilted in a backhand direction.
I	1.03	Usually simply a line with an angle in the centre.
P	.98	Rounded; pronouncedly tilted in a backhand direction.

It is clear from the table, that there is considerable connection between the perseveration score and the form of the reversed **w**. With the exception of **F**, all the subjects, who made angular ws, have very high scores. Both the subjects, who tilted their ws in a forehand direction, have high scores. Those who made them rounded and tilted in a backhand direction, tend to have moderate or low scores, and on the whole, those who tilted them a great deal have lower scores, than those who tilted them only slightly. The fact that Subject O had a rather high score, considering that she tilted her reversed ws pronouncedly, may be because they had a kind of tail, thus:  . The tilted ws made by other subjects did not have this. No explanation can, however, be suggested of B's having a rather lower score, than one would expect from the form of his ws, nor of L's having a rather higher one.

The rank order of the subjects, for the other two methods of scoring, can be seen by referring back to the tables showing the distribution of scores. For the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, the rank order is but little different from that for $\frac{X_1}{X_2}$, and the relationship, between the score and the form of the reversed **w**, is essentially the same. One would not expect very much connection, between the score $\frac{X_1 + X_2}{Y}$ and the form/

form of the reversed w , seeing that this score is supposed to be a measure of difficulty in alternating the two kinds of w . It is, however, also a measure of difficulty in forming the reversed w , as will be proved in the next chapter, and it is thus not altogether surprising, that here too there is some connection between the score and the form of the reversed w . The rank order of the subjects for this method of scoring differs from that for the other two methods of scoring mainly in that Subjects B, G and N are much higher, and Subjects L and O much lower. B and O are more in the position, which one would expect, considering the form of their reversed ws , than they are when the other two methods of scoring are used, but G and N are too high for the form of w used, and L possibly rather too low.

This connection between the perseveration score and the form of the reversed w does not, of course, prove that the perseveration score is not an indication of character, for the choice of a particular form may be the expression of certain trends or attitudes in the subject. It would, however, require a graphologist to elucidate the way, in which the choice of a particular form of reversed w reveals character.

The characteristic form of reversed w is not usually established until about the eighteenth trial. Earlier than that, the reversed w varies in form during/

during the same trial, and there is no clear connection between its form and the perseveration score. In other words, what has just been said does not apply to the perseveration scores for the w Test used by Cattell and Stephenson, which were those for the first and second trial. That the mean score for the trials from the sixth to the tenth depends to a considerable degree on the form of the reversed w, can be seen both by reference to the tables giving the rank order for this score, by the three methods of scoring, for the subjects, who had had no previous practice at the test, and by the consideration of the following facts with regard to Experiment II. Subject K was a member of the Friday Group, and made many of his reversed ws angular. He had the highest score of the group for the scoring $\frac{X_1}{X_2}$. In the Monday Group two subjects made angular reversed ws ; one had the second highest score in the group, for the scoring $\frac{X_1}{X_2}$, and the other a score $.77\sigma$ above the mean. All the rest of the Wednesday and Friday Group, and twenty-one of the Monday Group made their reversed ws rounded and tilted; the three subjects in the Monday Group, who were writing them most slowly at the end of the testing, made them rounded and upright.

If the facts concerning the form of w used, be considered in connection with the fact, that the lowest perseverators are on the whole the best differentiated/

differentiated from the rest of the group, by the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, it seems likely, that the reason for the better differentiation of the low perseverators, is that they adopt, early in the testing, a form of reversed w which is easily made, and thereafter do not usually change it much. It has already been stated, that the score of high perseverators, who make an awkward form of reversed w , is liable to decrease, if they discover an easier way of writing it.

c. Scores of individual subjects, with a short discussion of each subject.

The scores of each subject will now be given in full. Knowledge of these adds nothing substantial to the result already given, but a detailed study of each subject may be of some interest. It is possible, on the basis of a consideration of the details of the scores, to make some very tentative suggestions as to the causes of variation. There are, of course, two kinds of changes in the score, namely, gradual changes over a long period, and day to day fluctuations about a constant average, or super-imposed upon a gradual change. The commonest gradual change is a decrease in the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, mainly in the earlier trials, caused by practice having more effect on the reversed/

reversed w than on the ordinary one. This change has been mentioned as continuing, in the case of Subject I until the twenty-fifth trial. In most subjects it ceased, or practically ceased, before the fifteenth, and it was steepest at the very beginning. In the four highest perseverators, A, H, K and M, it either did not occur or was very slight; apparently in their case the reversed w did not become easier to write during the earlier trials. A few other gradual changes have been mentioned as apparently caused by practice. Others cannot be accounted for.

With regard to the day to day variations, while in a few cases the score has clearly been affected by some disturbing influence, in a very large number it varies for no apparent cause. There are also some cases in which an influence, which one would have been expected to be disturbing, has had no apparent effect on the score. It must, of course, be remembered, that systematic introspections were not asked for, so that fatigue, ill-health and depression may have been present in some cases without being reported by the subject, and may have been the cause of fluctuations. It seems, however, quite possible that the majority of the day to day variations may be due to obscure metabolic changes in the parts of the neuro-muscular system involved. Two facts seem to support this view. Subjects A, B, D and M gave fairly systematic introspections as/

as to the subjective sense of speed, and in the case of subjects B, D and M, though not in that of A, there was a strong correspondence between the subjective sense of speed and the actual speed. In D's case, there was sometimes felt to be an increase of speed apart from deliberate effort. In the second place, unusually high speeds were often reached, when a trial had been preceded by a period of rapid writing.

In order to show the degree to which scores were affected by disturbing, or potentially disturbing, influences, all factors which might possibly have disturbed any trial will be noted, even when the trial was retained on the ground that the score did not appear to have been affected. The scores of trials, which were discarded because they did appear to have been disturbed, will be given in brackets. Any factor will also be noted which may have affected the subject's emotional mood, as, for example, the fact that the trial was done just before, or just after, an examination, even although no introspection as to mood may have been given. It is noteworthy, how little disturbance of the perseveration score can be caused by alterations in mood sufficiently strong to cause other visible or audible effects. On the day of trial 49, Subject E was experiencing sufficient nervousness to cause an alteration in her tone of voice, but her/

her perseveration score is in no way extraordinary. While random observations such as this can establish nothing conclusive, it seems possible that Cattell[7] is being a little hasty, in using perseveration tests in a Child Guidance Clinic, in order to find whether a child's emotional condition has improved.

Where a subject took part in Experiment II as well as Experiment III, the score for Experiment II will be given also, so that there may be as complete a picture as possible of the changes through which the score has passed. In every case, the speed of all the parts of the test was greater at the beginning of Experiment III than at the beginning of Experiment II; in other words, the score in the test is affected by previous practice, even when this took place some months earlier.

Graphs of the speed and perseveration score of each subject will also be shown. On these, influences which may have disturbed the score will be marked according to the following system of notation, irrespective of whether the trial in question was discarded or not:

|| preceding a point, indicates that the trial which it represents was done after an interval of a day or more on which there was no trial.

X indicates the presence of some local and mechanical impediment; it includes S's pencil breaking/

breaking, his hands being cold, his being hindered by roughness of the table under the writing surface, and his having to stop to turn a page, take off his glasses, etc.

× indicates any pronounced distraction, whether from noise or from the subject's own thoughts.

○ indicates that a period of rapid writing preceded the test.

o indicates that the subject reported a condition of general fatigue or ill-health.

□ indicates that the subject reported the presence of an unpleasant emotional state such as depression.

Figures indicate the time at which the trial was done, it being an unusual one. The usual time at which each subject did the test will be given on the first graph.

The following notation will also be used on the graphs:

F on the graphs of speed, indicates that the subject felt, that this part of the trial in question was done unusually quickly or easily.

S on the graphs of speed, indicates that the subject felt, that this part of the trial in question was done unusually slowly, or with unusual difficulty.

□ indicates that the subject reported the presence of a pleasant emotional mood.

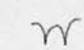
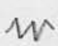
When/

When the line is double, the lighter line indicates the results obtained by counting imperfect ws as errors.

There is no significance in the fact, that some lines are drawn in pencil instead of in red; this is done simply to facilitate the reading of lines which cross.

Each subject will be briefly discussed, and the more interesting of his introspections will be given; short ones will be given along with the score of the trial to which they refer, longer ones separately after the scores and graphs. Where the exact words, written by the subject on the test paper, are quoted, this will be indicated by means of inverted commas.

Subject A. General Discussion.

Subject A is a man, aged thirty, who had had no previous practice at the test. He is of interest because of the fall in his scores, which has been already discussed, at the end of the period of testing. The decrease did not coincide exactly with the point, at which a subjective sense of greater ease in the formation of the reversed w was first felt. This sense was felt for the first time at the forty-seventh trial. The decrease in the score $\frac{X_1 + X_2}{Y}$ appears to begin at trial 39, and that in the score $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ at trial 40, while in the case of the score $\frac{X_1}{X_2}$ it is difficult to say whether it begins at trial 40 or at trial 44. Change in the actual appearance of the ws is very slight and gradual. There was a tendency to substitute curves for angles, in the junction of the hook and the initial upstroke to the main parts of the reversed w , and in the central division - a tendency to write the w thus:  , rather than thus:  - but individual ws vary a great deal. The point, at which ws , with curves substituted for angles in one part or another, become fairly frequent, is the thirty-ninth trial. Any visible change, which takes place at the forty-seventh trial, is extremely slight.

Subject A found the hook, both of the ordinary

and /

and of the reversed w , a great source of difficulty during most of the period of testing, and most of his errors are due to its omission. Although he does not ordinarily make an initial stroke when forming a w , he found it necessary to do this for the sake of the rhythm, always in his reversed ws , except for a short period at the beginning of the tenth trial, and often in his ordinary ones. Its omission or insertion in the ordinary ones may have had some slight effect on speed in the earlier part of Y. In X_1 it was put in throughout trials 1, 3, 4 and 6 and a few times in trials 7, 8 and 10, and here its insertion has not had any clear effect on speed. In the ordinary ws in Y , it was put in throughout trials 1 to 10, almost throughout trial 11, a few times in 12 and not at all from 13 to 26. A pronounced rise in speed occurs about where it begins to be omitted, which may or may not be caused by its omission. It was put in, in about half the ordinary ws in the Y part of trials 27, 29 and 30, and throughout trial 28 and the trials from 31 to the end. Here there is no clear effect on speed.

Subject A's introspections are of interest because they suggest, that the nervous and muscular processes, involved in doing the test, are immensely complex. The degree of subjective difficulty changed from day to day, and more than once there was a sense of/

of having learnt something new or of doing the test in a new way. The degree, to which A could work automatically, varied.

It is noteworthy that three of the four trials, in which A said that the two ws in Y did not form a unit, are represented by minima on the graph of speed for Y , and the fourth by a rather low point.

It can be seen from the graphs, that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ tended to decrease very gradually throughout the period of testing, until the more rapid drop at the end. The score $\frac{X_1 + X_2}{Y}$ varied about a constant level, till the drop at the end. The day to day fluctuations were great, and became greater still when imperfect ws were counted as errors. Distractions, whether inner or outer, and gaps in the testing, appear to have had very little effect on the score. As already noted, there was little correspondence between the subjective sense of speed and the actual speed.

Subject A. Scores when all ws* are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
1	Ap. 16	11.10 A.M.	34	20	56	.96	1.70	2.91	
2	Ap: 17	10.45 A.M.	45	26	68	1.04	1.73	3.05	
3	Ap: 18	11.5 A.M.	43	30	70	1.04	1.43	2.66	
4	Ap: 19	10.40 A.M.	44	33	72	1.07	1.33	2.55	Timed at home.
5	Ap: 22	10.50 A.M.	48	30	78	1.00	1.60	2.83	
6	Ap: 23	11 A.M.	44	32	74	1.03	1.375	2.565	Timed by S. himself.
7	Ap: 24	"	51	33	75	1.12	1.55	2.91	"
8	Ap: 25	10.45 A.M.	51	31	78	1.05	1.65	2.96	"
9	Ap: 26	10.15 A.M.	51	31	75	1.09	1.65	3.01	
10	Ap: 29	10.40 A.M.	51	32	76	1.09	1.59	2.93	
11	Ap: 30	10.30 A.M.	52	33	82	1.04	1.58	2.85	
12	May 1	10.35 A.M.	54	34	85	1.04	1.59	2.86	
13	May 2	10.40 A.M.	53	36	87	1.02	1.47	2.69	
14	May 3	10.45 A.M.	53	36	91	.98	1.47	2.63	
15	May 7	10.25 A.M.	52	36	88	1.00	1.44	2.62	
16	May 8	10.45 A.M.	53	38	80	1.14	1.39	2.715	
17	May 9	10.30 A.M.	53	35	83	1.06	1.51	2.79	S. "perhaps a little tired"
18	May 10	10.35 A.M.	51	34	82	1.04	1.50	2.74	
19	May 13	10.35 A.M.	51	38	78	1.14	1.34	2.65	A door banged during Y
20	May 14	10.25 A.M.	52	34	84	1.02	1.53	2.77	
21	May 15	10.45 A.M.	54	34	86	1.02	1.59	2.85	
22	May 16	10.50 A.M.	50	37	84	1.04	1.35	2.54	
23	May 17	10.45 A.M.	55	37	87	1.06	1.49	2.75	
24	May 21	10.10 A.M.	51	38	91	.97	1.34	2.45	
25	May 22	10.40 A.M.	53	38	90	1.01	1.39	2.57	

* Except, of course, "perseverative" errors and "interference" errors.

Subject A. Scores when all ws are counted as correct.

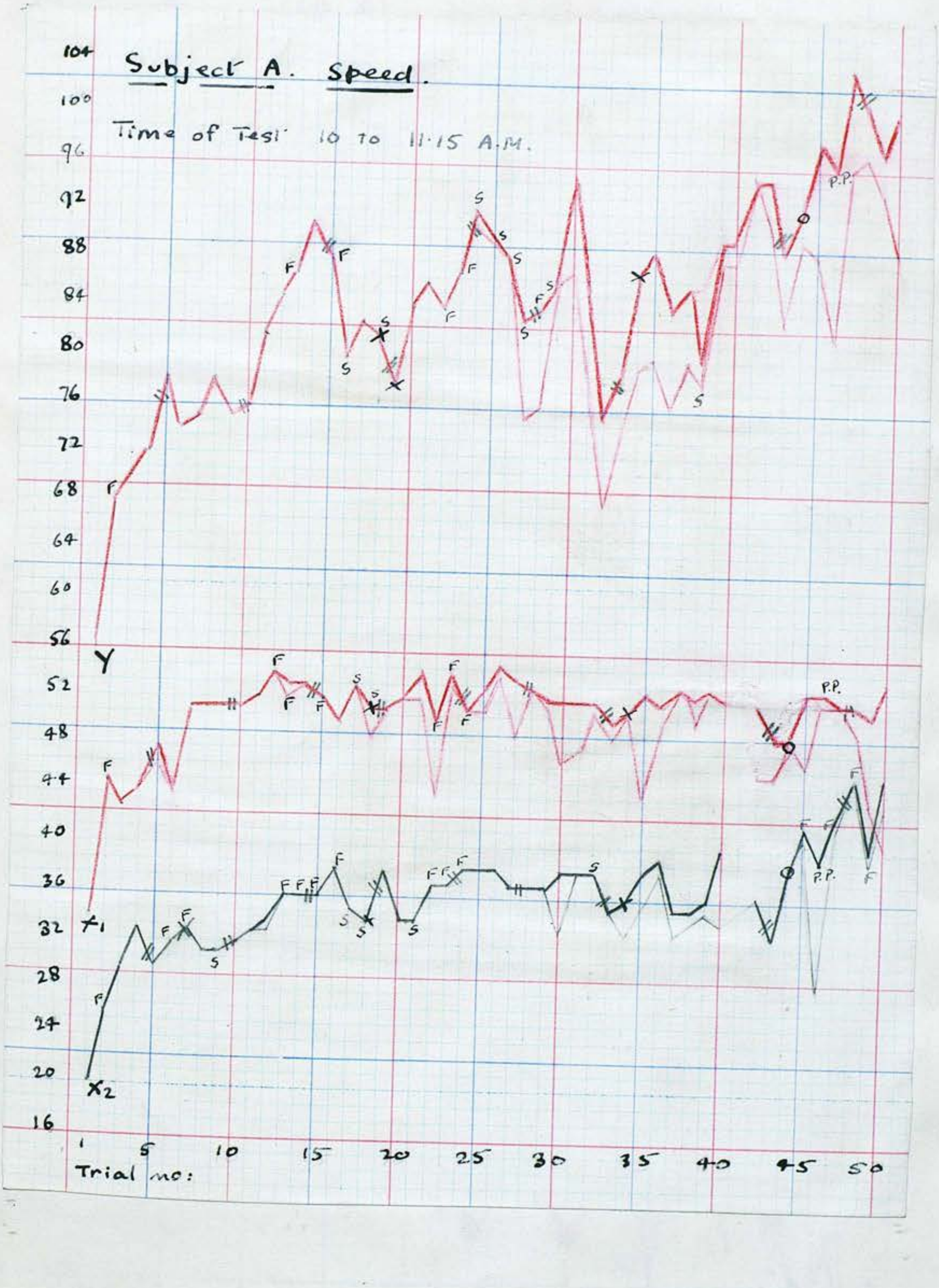
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
26	May 23	10.45 A.M.	55	38	88	1.06	1.45	2.70	
27	May 24	10.30 A.M.	54	37	83	1.10	1.46	2.76	
28	May 27	10.35 A.M.	53	37	84	1.07	1.43	2.69	
29	May 28	10.20 A.M.	52	37	86	1.03	1.41	2.62	
30	May 29	10.40 A.M.	52	38	96	.94	1.37	2.45	
31	May 30	"	52	38	86	1.05	1.37	2.58	
32	May 31	10.30 A.M.	52	38	75	1.20	1.37	2.76	
(33	June 3	10.25 A.M.	50	35	79	1.08	1.43	2.70)	S's pencil broke in X_1
34	June 4	10.55 A.M.	51	36	87	1.00	1.42	2.59	
35	June 5	10.40 A.M.	53	38	89	1.02	1.43	2.62	
36	June 6	10.30 A.M.	52	39	84	1.08	1.39	2.63	
37	June 7	10.40 A.M.	53	35	86	1.02	1.51	2.74	
38	June 10	10.15 A.M.	52	35	80	1.09	1.49	2.79	
39	June 11	10.40 A.M.	53	36	90	.99	1.47	2.65	
40	June 12	10.35 A.M.	52	41	90	1.03	1.27	2.43	
41	June 13	Result discarded owing to fault in procedure.							
42	June 14	10.45 A.M.	51	36	95	.92	1.42	2.49	
43	June 17	10 A.M.	49	33	89	.92	1.48	2.59	
44	June 18	10.40 A.M.	49	39	93	.95	1.26	2.31	
45	June 19	10.20 A.M.	52	42	98	.96	1.24	2.30	
(46	June 20	10.35 A.M.	53	39	96	.96	1.36	2.46)	Done with pressure pencil.
47	June 21	10.25 A.M.	52	43	104	.91	1.21	2.21	
(48	June 24	10.30 A.M.	52	46	101	.97	1.13	2.16)	Discarded on the ground that the interval may have affected the score
49	June 25	10.20 A.M.	51	40	97	.94	1.275	2.325	
50	June 26	10.40 A.M.	54	46	101	.99	1.17	2.24	

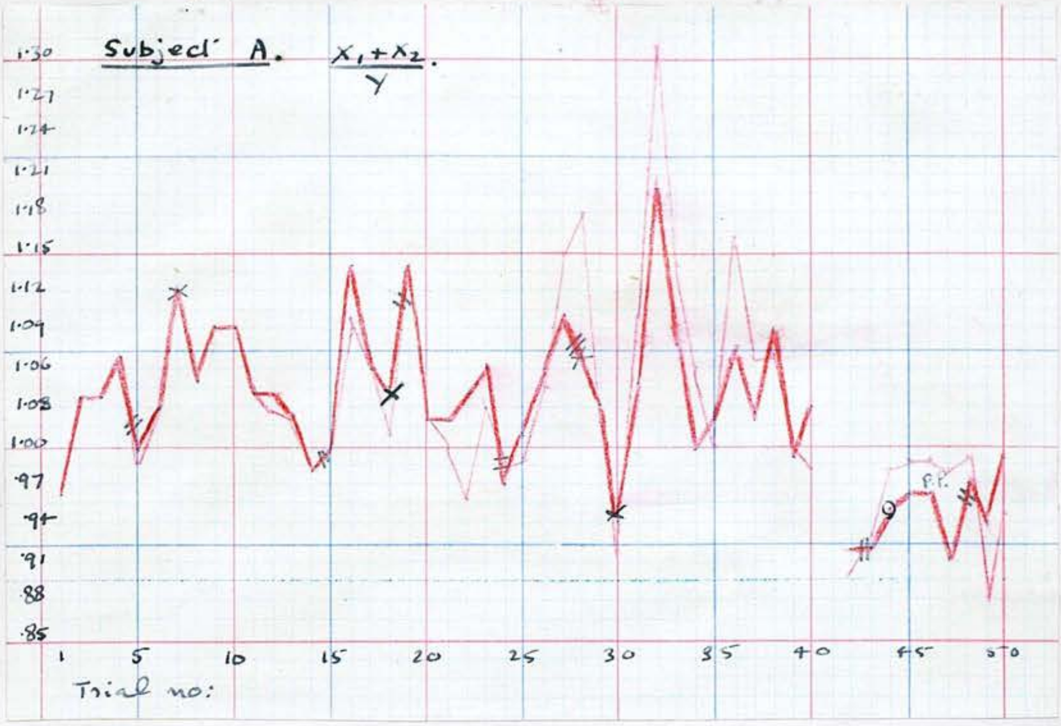
Subject A. Changes in score when imperfect ws are counted as errors. (The number of errors is shown in brackets under the number of correct ws.)

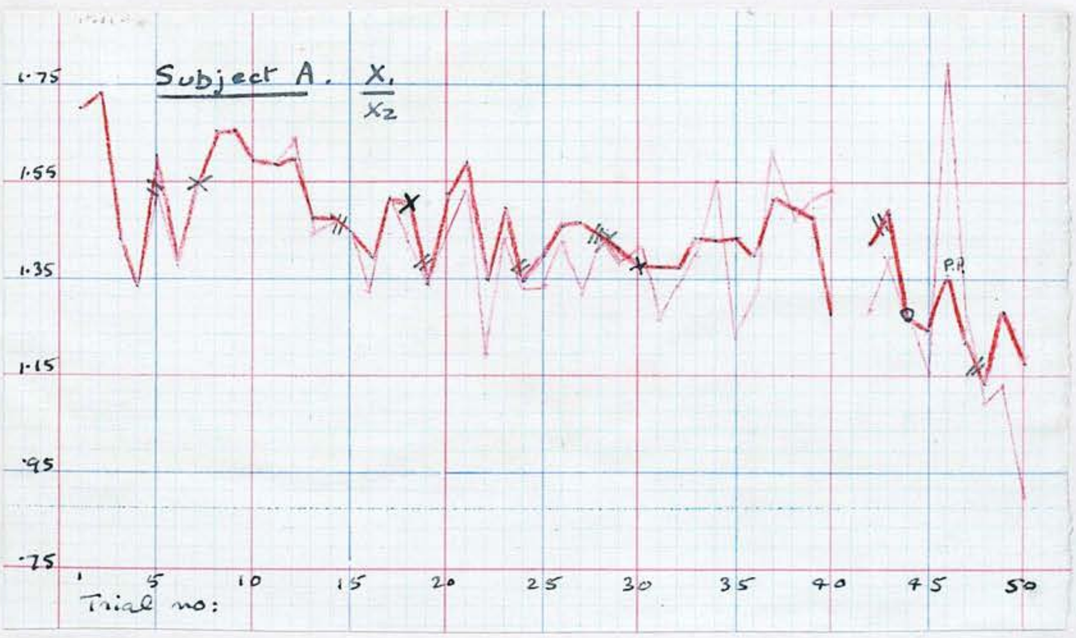
Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
5	47 (1)	30	78	.99	1.57	2.78
12	54	33 (1)	85	1.02	1.64	2.91
13	52 (1)	36	87	1.01	1.44	2.64
16	50 (3)	38	80	1.10	1.32	2.57
18	49 (2)	34	82	1.01	1.44	2.64
21	52 (2)	34	86	1.00	1.53	2.74
22	44 (6)	37	84	.96	1.19	2.24
23	53 (2)	37	87	1.03	1.43	2.65
24	51	38	91 (1)	.98	1.34	2.46
25	51 (2)	38	90	.99	1.34	2.47
26	54 (1)	38	88	1.05	1.42	2.65
27	49 (5)	37	75 (8)	1.15	1.32	2.63
28	53	37	76 (8)	1.18	1.43	2.82
29	51 (1)	37	86	1.02	1.38	2.57
30	47 (5)	33 (5)	87 (9)	.92	1.42	2.50
31	48 (4)	38	78 (8)	1.10	1.26	2.49
32	51 (1)	38	68 (7)	1.31	1.34	2.84
(33	49 (1)	35	74 (5)	1.14	1.40	2.72)
34	51	33 (3)	79 (8)	1.06	1.55	2.84
35	44 (9)	36 (2)	80 (9)	1.00	1.22	2.32
36	50 (2)	38 (1)	76 (8)	1.16	1.32	2.64

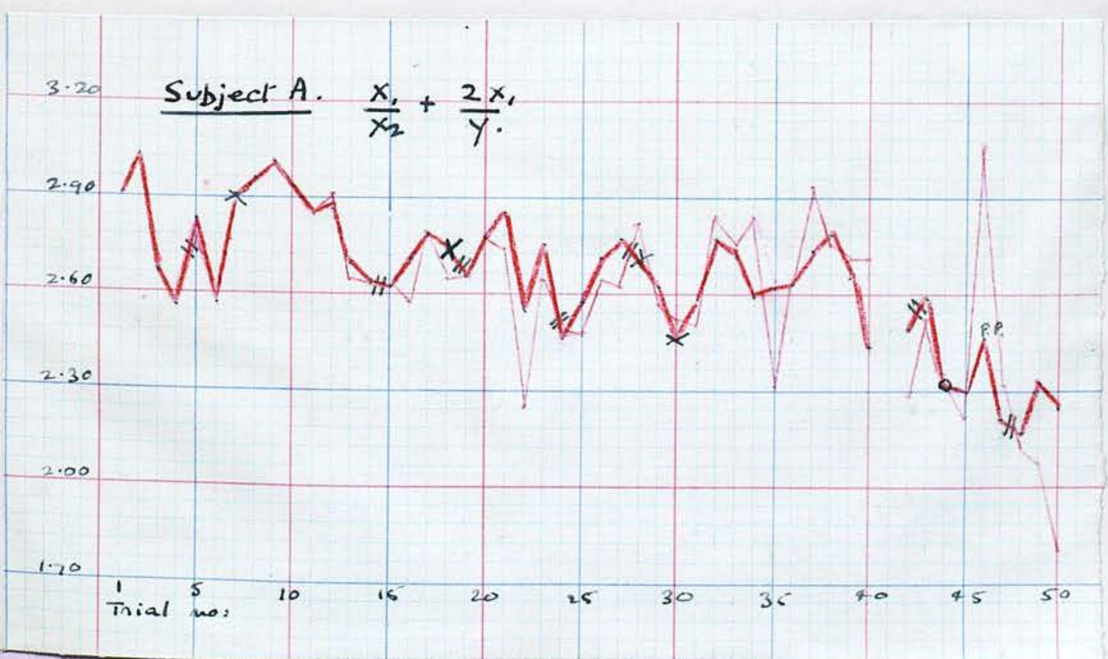
Subject A. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$
37	53	33 (2)	80 (6)	1.075	1.61	2.935
38	50 (2)	34 (1)	78 (2)	1.08	1.47	2.75
39	53	35 (1)	88 (2)	1.00	1.51	2.71
40	52	34 (7)	88 (2)	.98	1.53	2.71
42	46 (5)	36	91 (4)	.90	1.28	2.29
43	46 (3)	33	83 (6)	.95	1.39	2.50
44	49	39	90 (3)	.98	1.26	2.35
45	47 (5)	41 (1)	89 (9)	.99	1.15	2.21
(46	52 (1)	29 (10)	82 (14)	.99	1.79	3.06)
47	52	42 (1)	96 (8)	.98	1.24	2.32
(48	50 (2)	46	97 (4)	.99	1.09	2.12)
49	44 (7)	39 (1)	94 (3)	.88	1.13	2.07
50	40 (14)	45 (1)	89 (12)	.96	.89	1.79


Subject A. Speed.
Time of Test 10 to 11.15 A.M.
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
Y
X_1
X_2
Trial no:
1
5
10
15
20
25
30
35
40
45
50
P.P.


Subject A. $\frac{x_1+x_2}{Y}$.
1·30
1·27
1·24
1·21
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
·91
·88
·85
1 5 10 15 20 25 30 35 40 45 50
Trial no:
P.P.


Subject A. $\frac{X_1}{X_2}$
1·75
1·55
1·35
1·15
·95
·75
1 5 10 15 20 25 30 35 40 45 50
Trial no:
P.P.


Subject A. $\frac{X_1}{X_2} + \frac{2X_1}{Y}$.
3·20
2·90
2·60
2·30
2·00
1·70
1 5 10 15 20 25 30 35 40 45 50
Trial no:
P.P.

Subject A. Introspections.

Trial 1. S. said he found the reversed w very difficult at first, less so a little past the middle of the first line; the alternating ones seemed very easy because they formed a unit with an auditory rhythm.

Trial 2. S. said he thought about other things during X_1, though aware all the time of his handwriting. X_2 needed more attention and fell into an auditory-motor rhythm. Y fell very pronouncedly into such a rhythm. In X_2 he felt he had to make an initial stroke. (He did this on the first day, but did not remark on it.)

Trial 3. S. said he made a great effort to work fast in X_1, and found it difficult to change to X_2 after this. He found it easier to change from X_2 to Y. In Y he felt he must finish a pair at the end of a line. (He did so always except on the first day.)

Trial 4. "X_1 seemed, as before, quite automatic, as though 'I" were external to my fingers ... X_2 needed more attentive effort with 'I' in the performance; I had to keep in mind all the time the pattern I had to write. Y was, as before, written in pairs, and seemed easier than X_2; like in X_2 I had to keep the pattern in mind all the time, only here it was more definitely a kinaesthetic image. In Y I watched a visual image."

Trial/

Trial 5. S. said he felt less inhibited and that he was making his ws larger. (He was, slightly.) He got confused towards the end of X_2.

Trial 6. "X_2 seemed easier, though movement had to be imaginally practised before starting".

Trial 8. "Tried to do X_2 very quickly and got tied up; had to keep thinking of pattern all the time after that".

Trial 9. S. said he found X_2 more difficult - felt more "interference". When asked if this meant an actual impulse to make an ordinary w , he said it was not; it was at a purely motor level; the idea of making the reversed w was clear, and the auditory image of the rhythm, but the hand would not do what was wanted fast enough.

Trial 10. S. said he felt "tied up" at the beginning of X_2, till he realised that this was because he was omitting the initial stroke. He imagined himself doing reversed ws before X_2, and felt an interference effect in imagination.

Trial 11. S. said he tried to work very fast in X_2, and this seemed to cause a "jam". He also remarked on the fact, that the attempt to work fast in X_2, was tending to cause sharp corners - this had actually been occurring since trial 9.

Trial 13. S. said he became confused twice in Y owing/

owing to insufficient attention, but Y was for the first time semi-automatic. In X_2 he had difficulty owing to a tendency to make a mirror-image of the ordinary w, that is, to put the hook of the reversed w on the wrong end.

Trial 14. S. said he had a new experience in X_2 - he felt as if he had reached a new orientation - as if he was able to write from right to left, mirror-wise, although the ws were actually being written from left to right; it was almost as if his body was differently oriented. He felt he had done far more than usual in X_2 and had difficulty in beginning Y after it.

Trial 15. S. said it felt very easy, especially X_2. He got into difficulties once or twice in Y, because it had been going too easily, and his mind wandered.

Trial 16. S. said that X_2 was easy, and felt like a quite different task unrelated to X_1. He found Y difficult, making a number of rather bad reversed ws and feeling the two kinds of w as two unconnected things.

Trial 18. S. said he felt great difficulty, especially in X_2, because he had just had an exciting conversation about which he was still thinking.

Trial 19. S. said he had difficulty in making the "upstroke" (the hook?) of the reversed w in Y. He/

He did not feel the two ws as a unit. In X_2 he felt as if he was writing with the left hand, and experienced a strong resistence to moving from left to right; the ws are narrow and cramped together.

Trial 21. S. began X_2 automatically, and got into difficulties through thinking about it. Y was easier; the reversed w came automatically; here also there was difficulty if he thought.

Trial 26. S. said he had difficulty in Y, and seemed to have ceased to perceive the two ws as a unit.

Trial 27. S. said he put in the initial stroke on some of the ordinary ws in Y, to help himself because he got confused. When he did this, he began to miss out the hook on his reversed w. It was this hook that had caused difficulty during the last few days.

Trial 28. S. found Y easier again; it felt more like it did at the beginning of the series of tests, the ws forming pairs.

Trial 29. S. said he had difficulty with the hook of the reversed w in Y; when he did make it he seemed to do so, as it were, accidentally, as if he put the pencil on the paper and it made itself. He counted the ws in X, as he wrote, and tried to but could not in X_2.

Trial 30. S. had some difficulty with the reversed ws in Y, but on the whole it felt as it did near the/

the beginning of the experiment. He had difficulty in X_2 through trying to count.

Trial 31. S. said he had a good speed in X_1, then got into difficulties, perhaps through noticing the errors made the previous day.

Trial 32. S. became confused through noticing that he was making the hook of the reversed w on top of the next stroke.

Trial 34. "Marked difficulty through thinking about other matters."

Trial 37. S. said that it went better, but that he had some difficulty with the beginning of the ws in X_2.

Trial 38. S. said he became annoyed in Y because he could not help making the hook of the reversed w on the top of the next stroke; he went back and added some after.

Trial 44. S. said that he felt dull and sleepy, but that this did not seem to be reducing his speed.

Trial 47. S. said he found the reversed w easier; X_2 felt as fast as X , except at the beginning; he seemed to have learnt something new - to make what looked like a reversed w but was a new thing. He did a large number of reversed ws after the test, in an endeavour to find out what the difference was, and decided that he was making the hook and the rest of/

of the w in one movement.

Trial 49. S. said that he felt, that the new reversed w was somehow not really a w .

Subject B. General discussion.

Subject B is a man aged, twenty-five, who had had no previous practice at the test. He had a very high standard of neatness and accuracy in the formation of his ws , and was also very keen to increase his speed. He gave comparatively few introspections, most of which are not of sufficient interest to be quoted. In trials 23, 24, 28 and 29 S. reported that he was perceiving the two ws in Y as a unit, and in trial 25, that he tried to but could not. This seems to have had no consistent effect on the speed of Y. One or two introspections refer to attempts to improve the shape of the ws. Others referred to mood and physical condition, and these will be briefly indicated beside the scores for the trial to which they refer.

The graphs show that the score decreased rapidly in the early part of the testing, and gradually up to about the thirty-fifth trial, whichever method of scoring is used. The high score for the scoring $\frac{X_1 + X_2}{Y}$ at the first trial is especially noteworthy. The pronounced drop in speed, in X_2 and Y, at trial 20, seems to have been caused by the heat or fatigue, due to a long walk, and indisposition seems to have caused a drop in speed at trial 38, and perhaps at trial 5. Depression perhaps had an adverse effect on the/

the speed of Y at trials 11 and 22. There is unusually little increase of speed in X_1 in the course of the testing; apparently B habitually writes nearer his physiological limit than most people. A higher speed in X_1 was reached in the last trial than ever before. S. said he was excited during this trial, apparently about something unconnected with the testing; the high speed may possibly have been caused by this, or may be an end-spurt due simply to knowledge that it was the last trial.

Subject B. Scores when all ws are counted as correct.

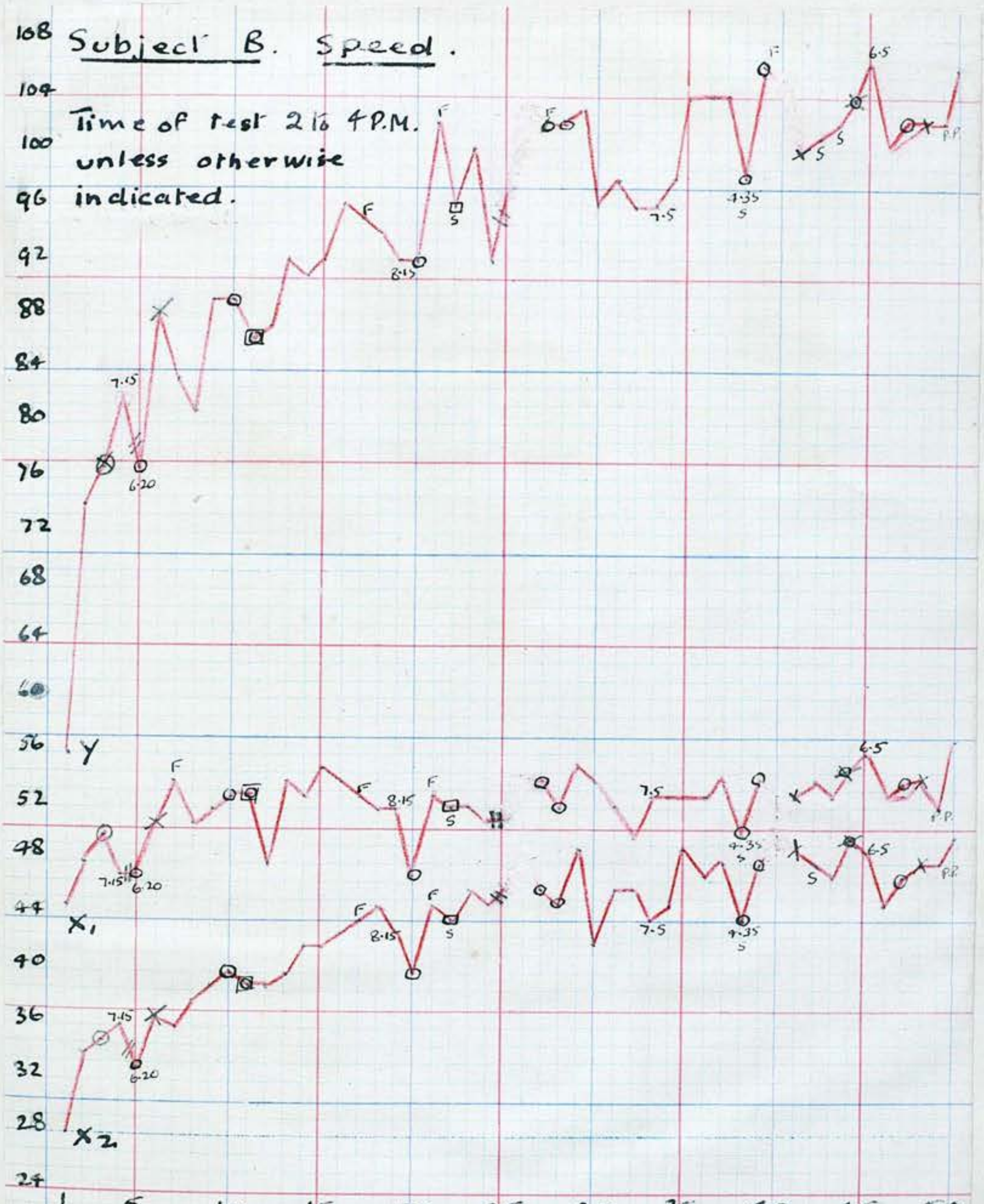
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
1	Ap:16	3.15 P.M.	45	28	56	1.30	1.61	3.22	
2	Ap:17	3.15 P.M.	48	34	74	1.11	1.41	2.71	
3	Ap:18	3.20 P.M.	50	35	77	1.01	1.43	2.73	Distraction during Y. S. had just been writing fairly fast.
4	Ap:19	7.15 P.M.	47	36	82	1.01	1.31	2.46	Timed at home or by friends.
5	Ap:21	6.20 P.M.	47	33	77	1.04	1.42	2.64	" " " " " "
									S. had slight headache.
6	Ap:22	3.15 P.M.	51	37	88	1.00	1.38	2.54	S. took glasses off in X_2 because rim was obscuring vision.
7	Ap:23	3.10 P.M.	54	36	83	1.09	1.50	2.80	
8	Ap:24	3.10 P.M.	51	38	81	1.10	1.34	2.60	Interrupted in Y by someone speaking to the writer.
9	Ap:25	3.25 P.M.	52	39	89	1.02	1.33	2.50	
10	Ap:26	3.20 P.M.	53	40	89 (1)	1.04	1.325	2.515	One "p" error. S. feeling slightly unwell.
11	Ap:27	3.20 P.M.	53	39	86	1.07	1.36	2.59	Timed at home or by friends. S. had slight headache and was a little depressed.
12	Ap:28	3.45 P.M.	48	39	87	1.00	1.23	2.33	Timed at home or by friends.
13	Ap:29	3 P.M.	54	40	92	1.02	1.35	2.52	
14	Ap:30	3.20 P.M.	53	42	91	1.04	1.26	2.42	
15	May 1	3.25 P.M.	55	42	92	1.05	1.31	2.51	
16	May 2	3.10 P.M.	54	43	96	1.01	1.26	2.385	
17	May 3	3.30 P.M.	53	44	95	1.02	1.20	2.32	
18	May 4	5.20 P.M.	52	45	94	1.03	1.16	2.27	Timed at home or by friends.
19	May 5	8.15 P.M.	52	43	92	1.03	1.21	2.34	Timed at home or by friends.
(20	May 6	6.30 P.M.	47	40	92	.95	1.175	2.195)	Timed at home or by friends. S. very hot after long walk.
21	May 7	3.20 P.M.	53	45	102	.96	1.18	2.22	
22	May 8	3.35 P.M.	52	44	96	1.00	1.18	2.26	S. somewhat depressed.
23	May 9	3.10 P.M.	52	46	100	.98	1.13	2.17	
24	May 10	3.25 P.M.	51	45	92	1.04	1.13	2.24	
25	May 12	4 P.M.	51	46	97	1.00	1.11	2.16	

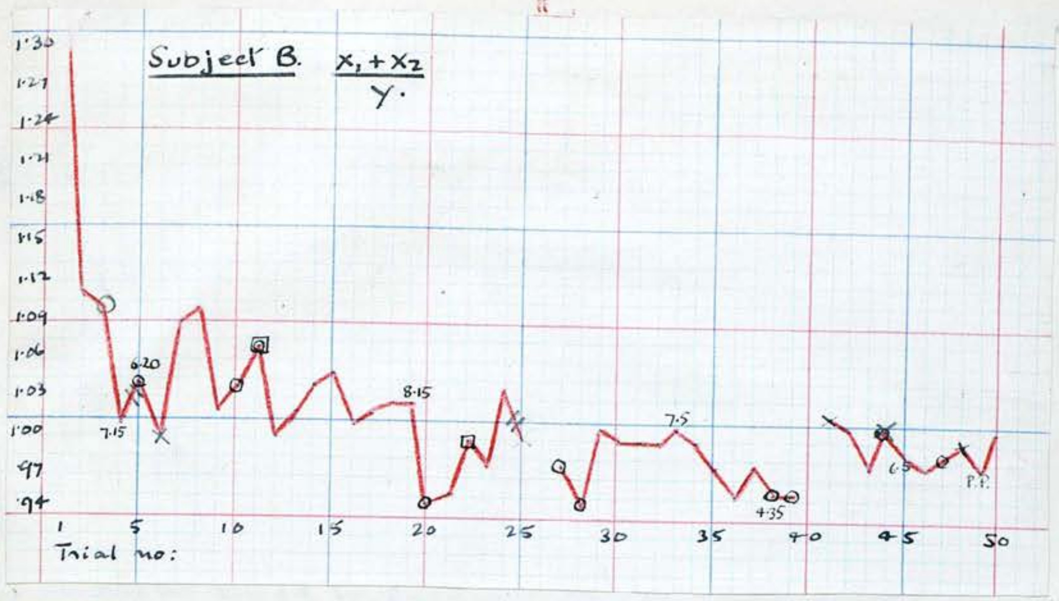
Subject B. Scores when all ws are counted as correct.

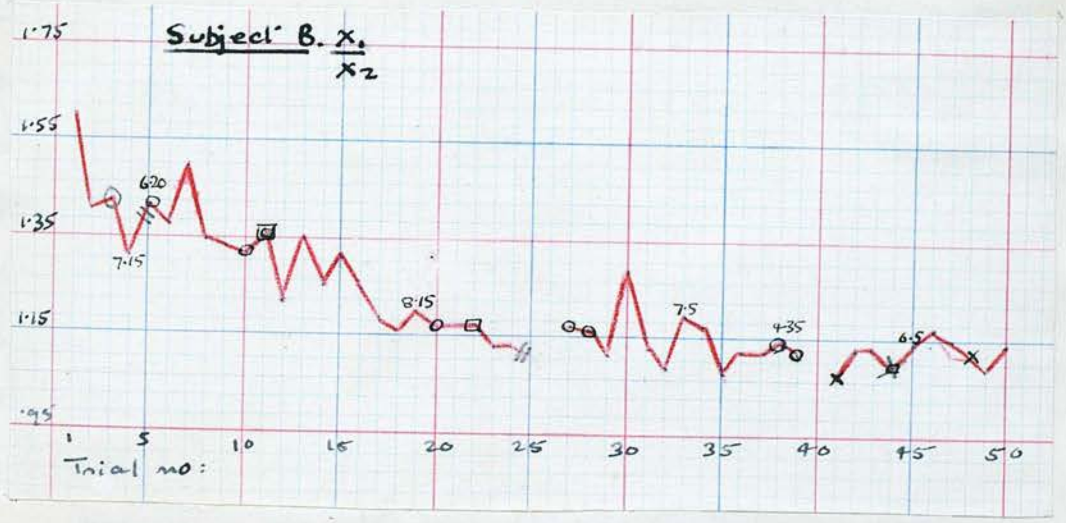
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
26	May 13	Result discarded owing to fault in procedure.							
27	May 14	3.25 P.M.	54	46	102	.98	1.17	2.23	S. very warm and sleepy.
28	May 15	3.25 P.M.	52	45	102	.95	1.16	2.18	S. extremely sleepy.
29	May 16	3.25 P.M.	55	49	103	1.01	1.12	2.19	
30	May 17	"	54	42	96	1.00	1.29	2.415	
31	May 18	3.30 P.M.	52	46	98	1.00	1.13	2.19	Timed at home or by friends.
32	May 19	3.20 P.M.	50	46	96	1.00	1.09	2.13	Timed at home or by friends.
33	May 20	7.5 P.M.	53	44	96	1.01	1.20	2.30	Timed at home or by friends.
34	May 21	2.20 P.M.	53	45	98	1.00	1.18	2.26	Timed at home or by friends.
35	May 22	3.35 P.M.	53	49	104	.98	1.08	2.10	
36	May 23	3.30 P.M.	53	47	104	.96	1.13	2.15	
37	May 24	"	54	48	104	.98	1.125	2.165	
(38	May 25	4.35 P.M.	50	44	96	.96	1.14	2.16)	Timed at home or by friends. S. slightly unwell.
39	May 26	3.30 P.M.	54	48	106	.96	1.125	2.145	Timed at home or by friends. S. slightly unwell.
40	May 27	Result discarded owing to fault in procedure.							
41	May 28	3.35 P.M.	53	49	100	1.02	1.08	2.14	
42	May 29	"	54	48	101	1.01	1.125	2.195	
43	May 30	"	53	47	102	.98	1.13	2.17	
44	May 31	3 P.M.	55	50	104	1.01	1.10	2.16	Noise in X_2 and Y.
45	June 1	6.5 P.M.	56	49	106	.99	1.14	2.20	Timed at home or by friends.
46	June 2	2.45 P.M.	53	45	100	.98	1.18	2.24	" " " " " "
47	June 3	3.25 P.M.	54	47	102	.99	1.15	2.21	S. sleepy.
48	June 4	3.35 P.M.	54	48	102	1.00	1.125	2.185	
(49	June 5	3.30 P.M.	52	48	102	.98	1.08	2.10)	Done with pressure pencil.
50	June 6	3.30 P.M.	57	50	106	1.01	1.14	2.22	

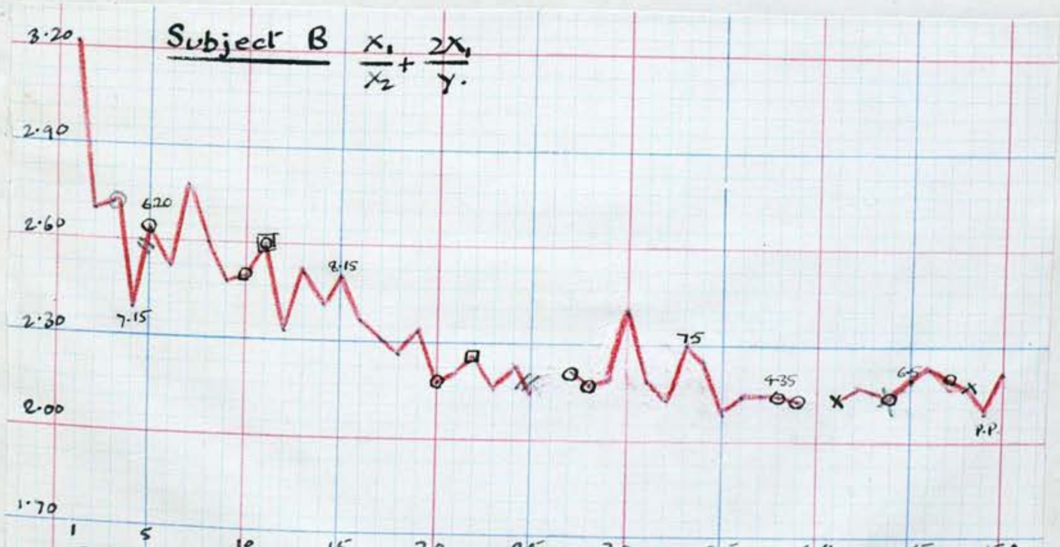
Subject B. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
47	53 (1)	47	101 (1)	.99	1.13	2.18


Subject B. Speed.
Time of test 2 to 4 P.M. unless otherwise indicated.
108
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
Y
X_1
X_2
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject B. $\frac{x_1 + x_2}{y}$
1·30
1·27
1·24
1·21
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
6·20
7·15
8·15
7·5
4·35
6·5
P.P.
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject B. $\frac{x_1}{x_2}$
1·75
1·55
1·35
1·15
·95
6·20
7·15
8·15
7·5
4·35
6·5
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject B $\frac{x_1}{x_2} + \frac{2x_1}{y}$
3·20
2·90
2·60
2·30
2·00
1·70
6·20
7·15
8·15
7·5
4·35
6·5
P.P.
1
5
10
15
20
25
30
35
40
45
50
Trial no:

Subject C. General Discussion.

Subject C is a woman, aged forty-four, who had had no previous practice at the test. She was omitted when the general result of the experiment was being considered, because she had been unable to do the test at a regular time, but, as has been already stated, it is worth while to give her scores because they are not actually more variable than those of several other subjects. There is, however, a slight indication of a tendency of the perseveration score to be higher, by all the methods of scoring, in the early morning and the late evening, than in the middle of the day. A table will be given of the mean scores for different times of day. The times, at which the test was done, will not be entered on the graphs, because they varied too much.

Trials 1, 13, 18, 26, 27, 33 and 34 were timed by the writer and the rest by C's relatives or friends. Trials 11, 12, 14 to 17, 19 to 23, and 32 were done on paper of a smaller size. This does not seem to have affected the score in any consistent way.

Subject C's reversed ws are slightly tilted in a backhand direction, and are often angular, but the hook is practically always joined by a curve. Her mean perseveration scores for the trials from the/

the sixteenth to the last are 1.00, 1.27 and 2.39 respectively by the three methods of scoring. The last two fit in with the view that the score is closely connected with the form of the reversed w.

Subject C gave no introspections.

The graphs show a fairly steep fall in the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ in the early trials, and a tendency in these scores to decrease gradually till after the fortieth trial. The score $\frac{X_1 + X_2}{Y}$ tends, if anything, to rise. Gaps in the testing seem to have had no consistent effect. The improvement in speed in X_2 and Y is much more gradual than in many subjects; the fact, that it is also gradual in M and R, suggests that subjects with poor motor ability do not improve so rapidly in the early trials, as subjects with good motor ability.

Subject C. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
1	Ap:16	10.15 A.M.	38	22	60	1.00	1.73	3.00	
2	Ap:17	6 P.M.	39	23	61	1.02	1.70	2.98	
3	Ap:18	10.10 A.M.	40	26	65	1.02	1.54	2.77	
4	Ap:19	9.20 A.M.	36	24	65	.92	1.50	2.61	
5	Ap:20	2 P.M.	41	28	68	1.01	1.46	2.67	
6	Ap:21	10.15 A.M.	43	31	71	1.04	1.39	2.60	
7	Ap:22	7.40 P.M.	41	26	71	.94	1.58	2.73	
8	Ap.27	1.50 P.M.	41	27	70	.97	1.52	2.69	
9	Ap:28	10.20 A.M.	44	30	73	1.01	1.47	2.68	
10	Ap:29	1.15 P.M.	38	30	78	.87	1.27	2.24	
11	Ap:30	5 P.M.	42	29	71	1.00	1.45	2.63	
12	May 1	1.25 P.M.	43	32	76	.99	1.34	2.47	
13	May 2	11 A.M.	44	33	76	1.01	1.33	2.49	
14	May 3	6.40 P.M.	44	32	75	1.01	1.375	2.545	
15	May 4	3.20 P.M.	40	33	75	.97	1.21	2.28	
16	May 5	5.55 P.M.	42	36	80	.975	1.17	2.22	
17	May 6	1.35 P.M.	42	31	73	1.00	1.35	2.50	
18	May 7	12.55 P.M.	42	34	78	.97	1.24	2.32	
19	May 8	12.25 P.M.	44	36	76	1.05	1.22	2.38	
20	May 9	1.50 P.M.	42	33	78	.96	1.27	2.35	
21	May 10	9.30 A.M.	42	30	73	.99	1.40	2.55	
22	May 12	1.15 P.M.	42	34	75	1.01	1.24	2.36	
23	May 13	1.10 P.M.	42	33	77	.97	1.27	2.36	
24	May 14	11 A.M.	44	32	78	.97	1.375	2.505	
25	May 15	2 P.M.	45	34	77	1.03	1.32	2.49	

Subject C. Scores when all ws are counted as correct.

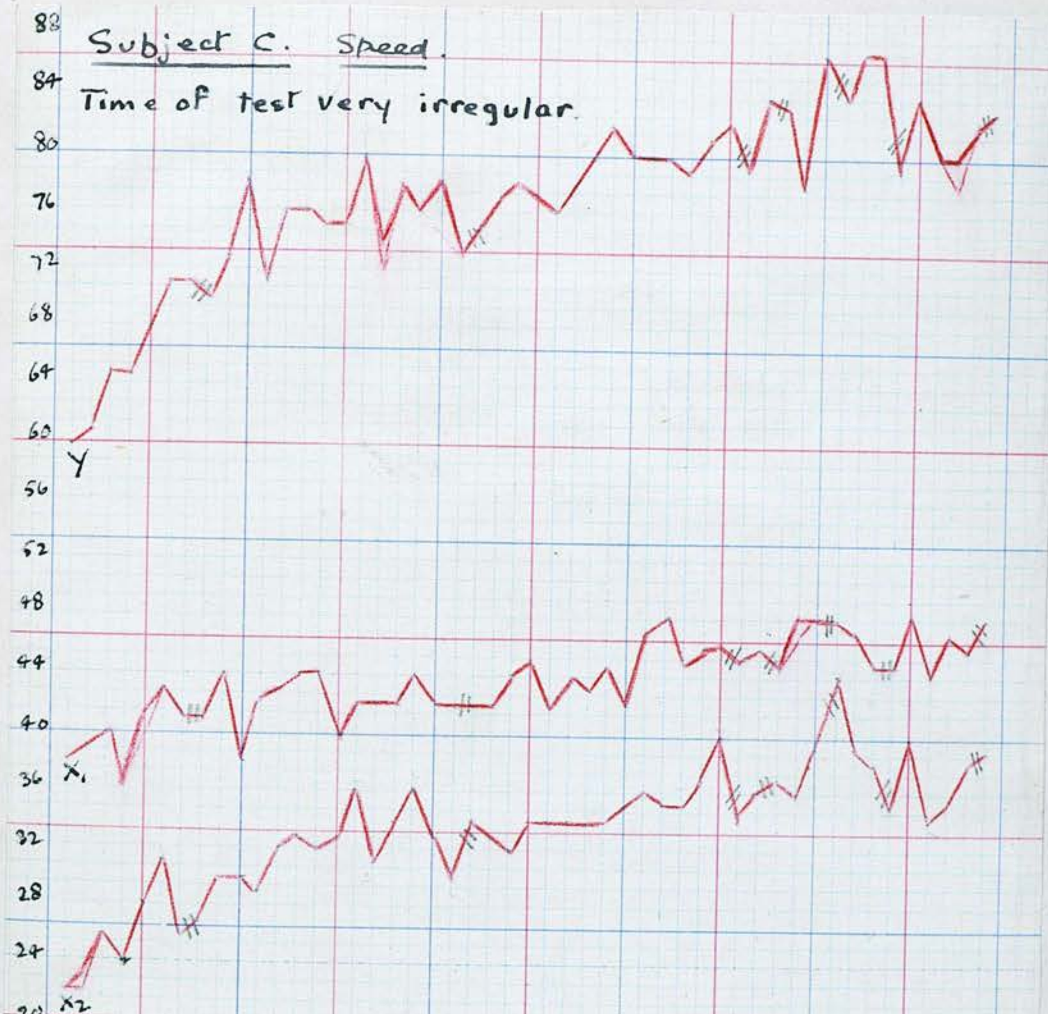
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
26	May 16	11 A.M.	42	34	76	1.00	1.24	2.35	
27	May 17	11 A.M.	44	34	78	1.00	1.29	2.42	
28	May 18	1.45 P.M.	43	34	80	.96	1.27	2.345	
29	May 19	1.5 P.M.	45	34	82	.96	1.32	2.42	
30	May 20	2 P.M.	42	35	80	.96	1.20	2.25	
31	May 21	9 P.M.	47	36	80	1.04	1.31	2.485	
32	May 22	8 P.M.	48	35	80	1.04	1.37	2.57	
33	May 23	11 A.M.	45	35	79	1.01	1.29	2.43	People came into the room during X_2, fairly quietly.
34	May 24	11 A.M.	46	37	81	1.02	1.24	2.38	Someone came in at the end of X_1.
35	May 25	2 P.M.	46	40	82	1.05	1.15	2.27	
36	May 28	5.50 P.M.	45	34	79	1.00	1.32	2.46	
37	May 29	9.45 P.M.	46	36	84	.98	1.28	2.38	
38	May 31		45	37	83	.99	1.22	2.30	S. omitted to record time.
39	June 1	5.30 P.M.	48	36	78	1.08	1.33	2.56	
40	June 2	5 P.M.	48	39	87	1.00	1.23	2.33	
(41	June 4	1.50 P.M.	48	44	84	1.10	1.14	2.23)	Discarded on the ground that the interval may have affected the score.
42	June 5	6.30 P.M.	47	39	87	.99	1.21	2.29	
43	June 6	1 P.M.	45	38	87	.95	1.18	2.21	
44	June 8	2.45 P.M.	45	35	79	1.01	1.29	2.43	
45	June 9	10.30 A.M.	48	40	84	1.05	1.20	2.34	
46	June 10	9 P.M.	44	34	80	.975	1.29	2.39	
47	June 11	10.40 A.M.	47	35	80	1.025	1.34	2.515	
48	June 12	10.30 P.M	46	38	82	1.02	1.21	2.33	
49	June 14	9.50 A.M	48	39	83	1.05	1.23	2.39	

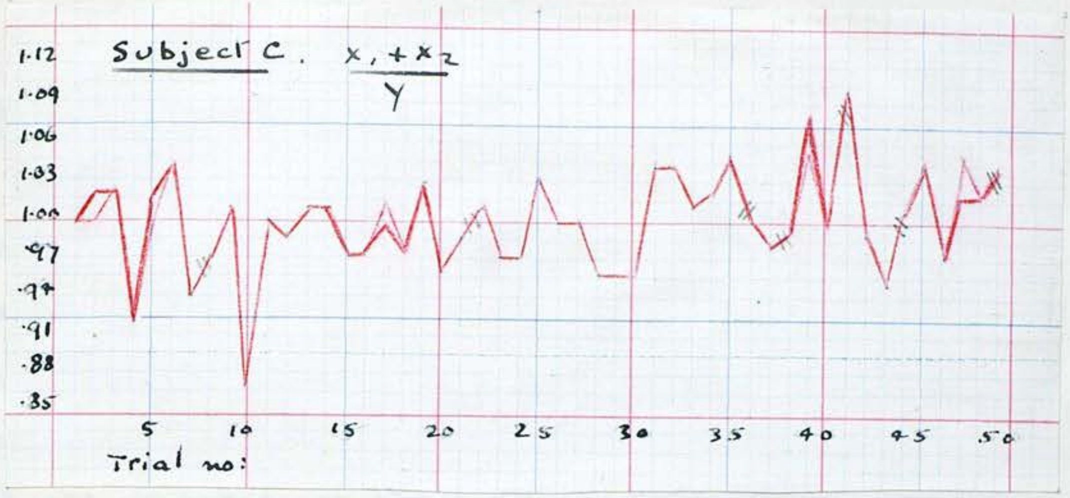
Subject C. Changes in score when imperfect ws are counted as errors.

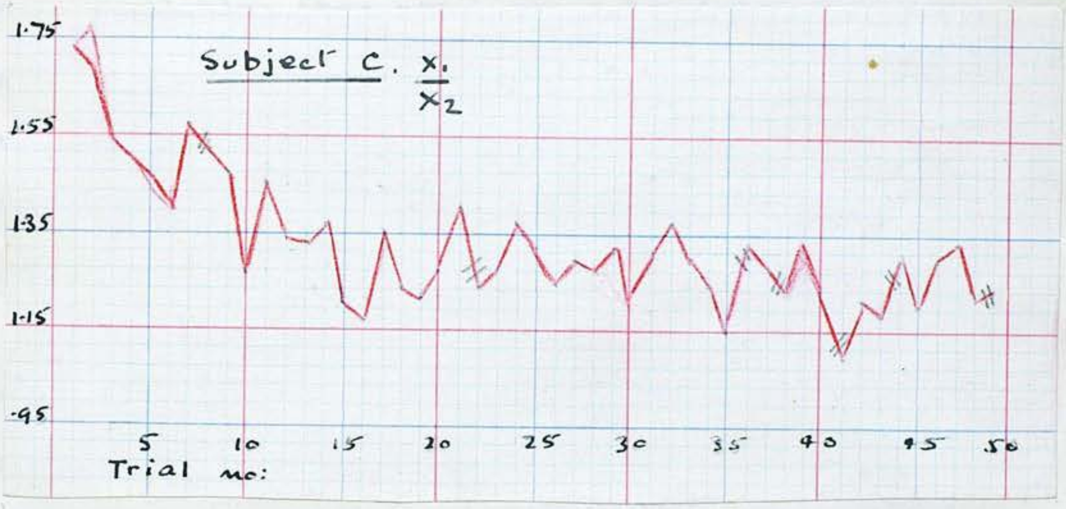
Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
2	39	22 (1)	61	1.00	1.77	3.05
5	40 (1)	28	68	1.00	1.43	2.61
17	42	31	72 (1)	1.01	1.35	2.52
39	47 (1)	36	78	1.06	1.31	2.52
47	47	35	78 (2)	1.05	1.34	2.55

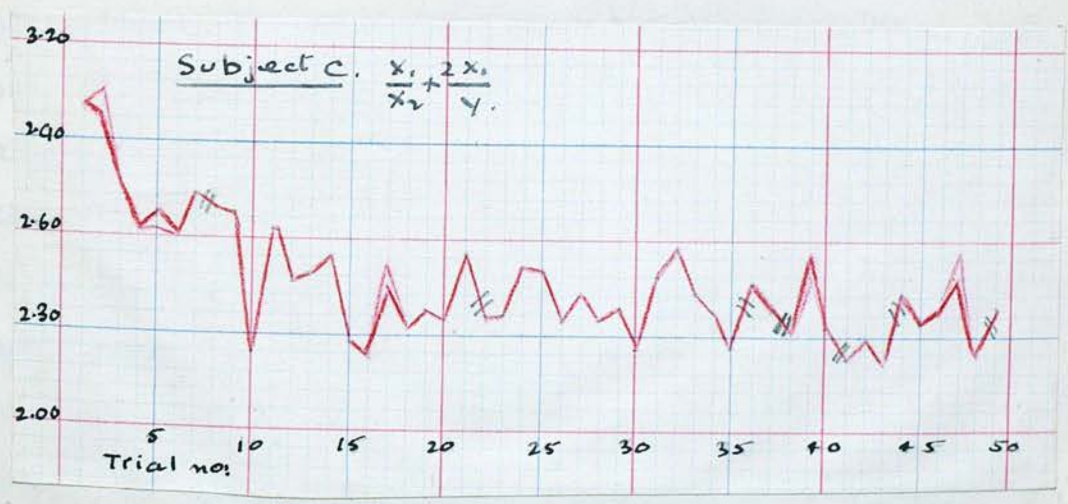
Subject C. Table of mean perseveration scores for trials done at different times of day.

Time	No: of trials included in average.	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$
9 - 10.55 A.M.	5	1.03	1.30	2.46
11 A.M.- 12.55 P.M.	7	1.00	1.27	2.40
1 - 2.55 P.M.	11	.99	1.26	2.36
5 - 6.55 P.M.	5	1.01	1.25	2.37
7 - 8.55 P.M.	1	1.04	1.37	2.57
9 - 10.55 P.M.	4	1.00	1.27	2.40


Subject C. Speed.
Time of test very irregular.
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
Y
X1
X2
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject C. $\frac{x_1 + x_2}{Y}$
1.12
1.09
1.06
1.03
1.00
.97
.94
.91
.88
.85
5 10 15 20 25 30 35 40 45 50
Trial no:


Subject C. $\frac{x_1}{x_2}$
1.75
1.55
1.35
1.15
.95
5 10 15 20 25 30 35 40 45 50
Trial no:


Subject C. $\frac{x_1}{x_2} + \frac{2x_1}{Y}$.
3.20
2.90
2.60
2.30
2.00
5 10 15 20 25 30 35 40 45 50
Trial no:

Subject D. General Discussion.

Subject D is the present writer herself; she is twenty-eight years old. She had had a considerable amount of previous practice at the test, probably about fifteen trials. This was done under rather unscientific conditions, and many of the results were not all recorded, as there was no intention of publishing them. The scores for the first attempt are, however, available; they are 1.09, 1.74 and 3.12 for the three methods of scoring respectively. This shows that, as in the case of most other subjects, the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ fell very considerably as a result of practice.

Subject D was usually timed by B, sometimes by R ; the days on which the latter was the case will be indicated when the scores are given. D counted her own score at once on the first day, but did not count the scores for the other trials till the end of the testing. B criticised her for making her reversed ws tilted. This caused her to be more careful in the formation of them at some trials than at others. The degree of care may have had some effect on the speed in X_2, though the latter does not always vary with it. As a result of criticism by B on the first day, D made an effort to keep the reversed ws fairly straight; she reported that she was especially careful during trial 6. After trial

10/

10 she reported that she had begun to be less careful, because she had just been advised to score other subjects more leniently, than she was doing. The speed in X_2 in this trial was actually lower than in trials 7 and 9. After trials 13 and 14, she reported that the style of the reversed w seemed to be changing, and that it felt easier in consequence. The speed in X_2 begins to rise to a higher plateau about here. The change in the form of the reversed w is objectively slight and gradual; it consists partly in an increase in the "tilt", partly in a slight curtailment of the original up and down movements, which are by now practically left and right, and partly in the appearance of a slight tendency to angularity; the w changes from to . The culmination of the process seems to be indicated in the introspection written after trial 21: "The reversed w is felt now as practically just a wavy line, easy and pleasant to make." In trials 30, 31 and 33, however, Subject D again reported that she was trying to make the reversed ws straighter. X_2 was done slowly in trials 31 and 33 but not in 30.

D gave a large number of introspections. Most of them are not interesting enough to be reported verbatim, but lend themselves rather to being summarised and discussed in a general way. This will accordingly/

accordingly be done under the heading "introspections".

The graphs show that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ decrease sharply between trial 6 and trial 7, and gradually up to trial 30, after which they tend to rise. The score $\frac{X_1 + X_2}{Y}$ varies about a constant level. There is no sharp increase in speed in X_2 and Y in the early trials, presumably because of the large amount of previous practice. The fact, that a higher speed was reached in X_1, when the pressure pencil was used, and in Y at the last trial, than at any other time, shows that in general D was not reaching her maximum speed. This may be because she found it impossible not to get a little bored with the test, a fact which may also account for the greater amplitude of the day to day fluctuations in score towards the end of the period. Fatigue, ill-health, distraction, and changes of time appear to have had no consistent effect on the score, except perhaps that physical lassitude and sleepiness sometimes seem to have caused a drop in the speed of Y. Gaps in the testing perhaps tended to cause decreases in speed in all the parts.

Subject D. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks
1	Ap:16	3.20 P.M.	45	35	81	.99	1.29	2.40	
2	Ap:17	"	46	33	78 (1)	1.01	1.39	2.57	"p" error
3	Ap:18	3.25 P.M.	47	34	84	.96	1.38	2.50	
4	Ap:19	6 P.M.	47	32	83	.95	1.47	2.60	Timed by R.
5	Ap:20	3.20 P.M.	46	35	86	.94	1.31	2.38	Timed by R. S. tired, mainly in feet but to some extent generally. Interruption in X_1 and Y.
6	Ap:21	5.25 P.M.	49	34	90	.92	1.44	2.53	Timed by R.
7	Ap:22	3.20 P.M.	41	40	83	.98	1.025	2.015	
8	Ap:23	3.15 P.M.	45	35	84	.95	1.29	2.36	S. tired, both in legs and generally.
9	Ap:24	3.15 P.M.	46	41	92	.95	1.12	2.12	Interruption in Y.
10	Ap:25	3.30 P.M.	45	39	91	.92	1.15	2.14	
11	Ap:26	3.25 P.M.	47	40	85	1.02	1.175	2.285	
12	Ap:27	4.15 P.M.	48	41	88 (1)	.99	1.17	2.26	Timed by R. Rest pauses of unknown length, probably less than 30 Seconds. S. very tired. "p" error.
13	Ap:28	7 P.M.	50	42	95	.97	1.19	2.24	Timed by R.
14	Ap:29	3.5 P.M.	51	42	100	.93	1.21	2.23	
15	Ap:30	3.25 P.M.	50	43	91	1.02	1.16	2.26	S. tired in back and legs, and disinclined to make effort.
16	May 1	3.30 P.M.	47	42	98	.91	1.12	2.08	

Subject D. Scores when all ws are counted as correct.

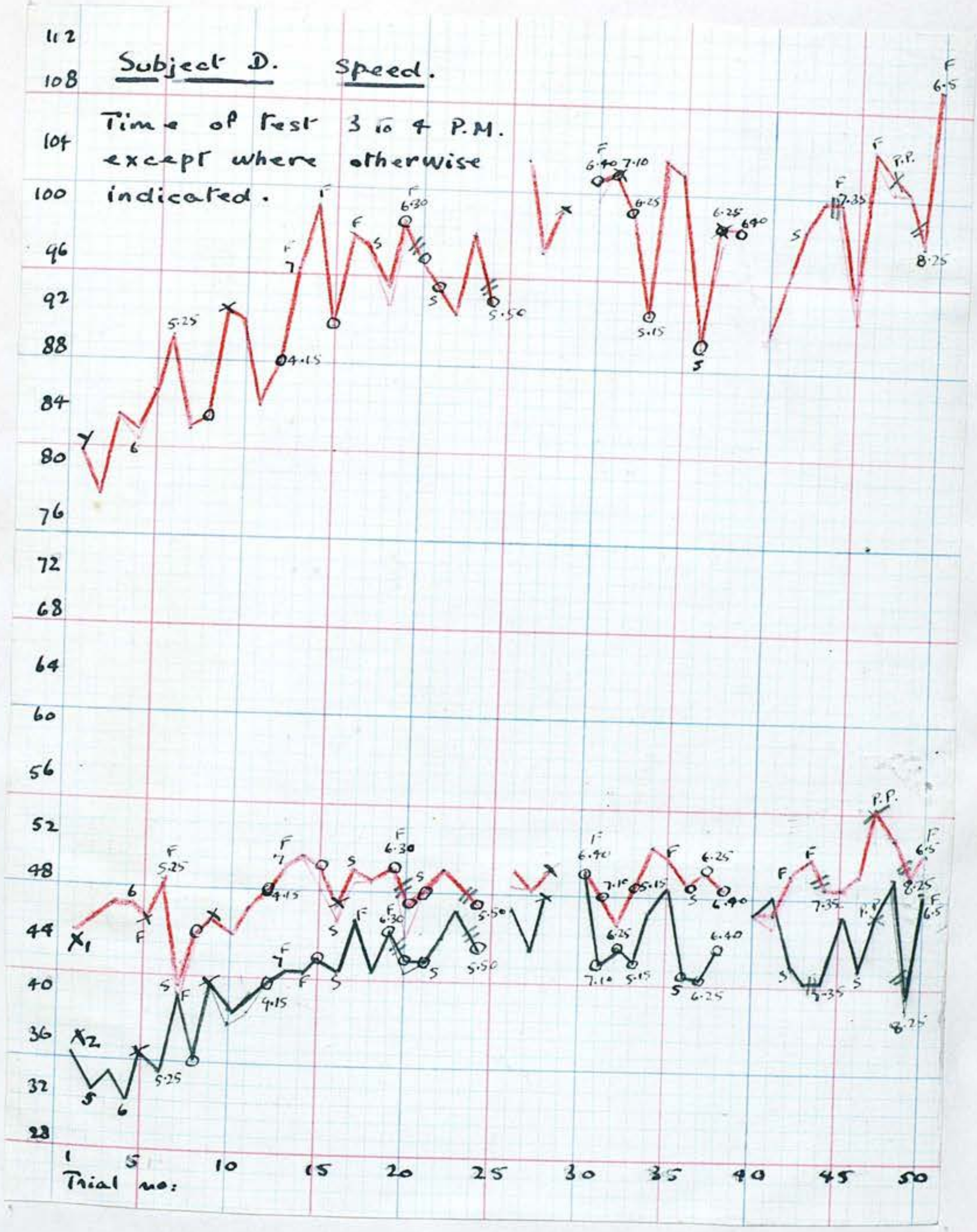
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
17	May 2	3.20 P.M.	50	46	97	.99	1.09	2.12	
18	May 3	3.35 P.M.	49	42	94	.97	1.17	2.21	
19	May 4	6.30 P.M.	50	45	99	.96	1.11	2.12	Timed by R. S. had beginning of slight cold, and felt a little dazed because she had slept in the afternoon.
20	May 7	3.25 P.M.	47	43	96	.94	1.09	2.07	S. tired.
21	May 8	3.40 P.M.	48	43	94	.97	1.12	2.14	S. very sleepy; had had good night after succession of late ones.
22	May 9	3.15 P.M.	50	45	92	1.03	1.11	2.20	
23	May 10	3.30 P.M.	49	47	98	.98	1.04	2.04	
24	May 12	5.50 P.M.	47	44	93	.98	1.07	2.08	Timed by R. False start in Y, as she failed to start watch. S. sleepy.
25	May 13	Result discarded owing to fault in procedure.							
26	May 14	3.30 P.M.	50	47	104	.93	1.06	2.02	
27	May 15	"	48	44	97	.95	1.09	2.08	
28	May 16	"	50	48	100	1.00	1.04	2.06	
29	May 17	Result discarded owing to fault in procedure.							
30	May 18	6.40 P.M.	50	50	102	.98	1.00	1.98	Timed by R. S. had slight headache.
(31	May 19	7.10 P.M.	48	43	103	.88	1.12	2.05)	Timed by R. S. rather tired. Interruption in Y.
32	May 20	6.25 P.M.	46	44	100	.90	1.05	1.97	Timed by R. S. tired owing to bad night.

Subject D. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
33	May 21	5.15 P.M.	49	43	92 (1)	1.00	1.14	2.21	Timed by R. S. tired in legs and languid. "p" error.
34	May 22	3.40 P.M.	52	47	104	.95	1.11	2.11	
35	May 23	3.25 P.M.	51	49	103	.97	1.04	2.03	Distraction in X_2 and Y.
36	May 24	3.30 P.M.	49	42	90	1.01	1.17	2.26	S. rather unwell.
37	May 25	6.25 P.M.	50	42	99	.93	1.19	2.20	Timed by R. S. very tired mentally. "p" error.
38	May 26	6.40 P.M.	49	44	99	.94	1.11	2.10	Timed by R. S. very tired mentally.
39	May 27	Result discarded owing to fault in procedure.							
(40	May 28	3.40 P.M.	47	47	90	1.04	1.00	2.04)	S. in bad mood.
41	May 29	"	47	48	95	1.00	.98	1.97	Interruption in Y.
42	May 30	3.25 P.M.	50	43	99	.94	1.16	2.17	
(43	May 31	3.10 P.M.	51	42	101	.92	1.21	2.22)	Interruption in Y.
44	June 2	7.35 P.M.	49	42	101 (1)	.90	1.17	2.14	Timed by R. "p" error.
45	June 3	3-4 P.M.	49	47	94	1.02	1.04	2.08	Exact time not recorded.
46	June 4	3.40 P.M.	50	43	105	.89	1.16	2.11	
(47	June 5	3.45 P.M.	55	47	103	.99	1.17	2.24)	Done with pressure pencil.
48	June 6	3.40 P.M.	53	50	102	1.01	1.06	2.10	
(49	June 8	8.25 P.M.	50	41	98	.93	1.22	2.24)	Timed by R. S. sleepy.
50	June 9	6.5 P.M.	52	49	110	.92	1.06	2.01	Timed by R.

Subject D. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
4	47	32	82 (1)	.96	1.47	2.62
7	40 (1)	40	83	.96	1.00	1.96
10	45	38 (1)	91	.91	1.18	2.17
11	47	39 (1)	85	1.01	1.21	2.32
15	48 (2)	43	91	1.00	1.12	2.17
16	46 (1)	42	98	.90	1.10	2.04
17	49 (1)	46	97	.98	1.07	2.08
18	49	42	93 (1)	.98	1.17	2.22
20	45 (2)	42 (1)	96	.91	1.07	2.01
26	49 (1)	47	104	.92	1.04	1.98
30	50	50	101 (1)	.99	1.00	1.99
37	50	42	98 (1)	.94	1.19	2.21
41	46 (1)	48	95	.99	.96	1.93
45	49	47	92 (2)	1.04	1.04	2.11
(47	55	47	102 (1)	1.00	1.17	2.25)
(49	50	40 (1)	98	.92	1.25	2.27)


Subject D. Speed.
Time of test 3 to 4 P.M. except where otherwise indicated.
Trial no:
X1
X2
P.P.

Subject D. Introspections.

One introspection is of sufficient interest to be quoted, because it reveals a condition in which the performance of the test was almost, but not quite, automatic. It was written after trial 10, and is as follows: "Thought about something else in Y, then suddenly realised I was making alternating ws and wondered if it was right, and was surprised at its being so easy."

Many of the introspections deal with the subjective sense of speed. A sense of high speed, with little effort, was reported with regard to the X_1 part of trials 5 and 6, and the whole of trial 19. This, corresponding fairly well, as it does, with objective speed, is the more surprising as D was tired at trial 5, and at trial 19 had been to sleep earlier in the afternoon, because of fatigue caused by a short night, and was in consequence feeling a little dazed. A deliberate effort to work fast was reported in trial 5 in Y, in trial 13 at the beginning of X_1, in trial 17 throughout X_1 and X_2, and at the end of Y, and in trial 26 in X_1. In the last two cases, the effort was felt to be fruitless; on the other hand in X_1 and X_2 of trial 17, there was a sense of great speed coming spontaneously, apart from the effort. On all these occasions, except in X_2 of trial 17, where/

where the speed was really very high, the actual speed was fairly great, but not at a maximum. "Spurts" were reported in a number of trials; the actual speed of the part concerned is high in most cases, but not in all. In one of them, in which the actual speed is very high, the wording is "an increase of speed became possible", which suggests, that the spurt was due to something outside the control of the will. Another introspection which suggests, that the speed was due to factors outside voluntary control is: "the hand seemed to move fast, though I did not make any unusual effort to work fast."

S. often reported that she worked mechanically, or that the mind wandered. This suggests that the maximum effort was not being made, but the trials in which it occurred were by no means all done slowly. A certain degree of absent-mindedness is not, however, always a hindrance in work of a mechanical type. Robinson and Bills[34], in their investigation into factors in the work decrement, found that it was actually a help with certain kinds of work, if the subjects thought of something else. On certain occasions, however, absent-mindedness was reported to have caused errors or "blocks". Two of the errors thus causes were the "perseverative" errors in trials 12 and 35. Subject D was not quite sure, whether those in trial 39 were due to the mind wandering, or to fatigue. She was/

was unable to account for those in trials 2, 33 and 44.

"Blocks" were reported in a number of other cases, besides those in which they were caused by absent-mindedness. They were reported occasionally by other subjects and are a characteristic of repetitive, mechanical work, being mentioned by Robinson and Bills[34] in the article referred to above. In D's case they were reported less frequently in X_2 than in X_1 and Y , but the other subjects did not give enough introspections, to enable a general conclusion to be drawn, as to their relative frequency in different parts of the test.

In a number of trials and parts of trials, D. reported that she wrote more lightly than usual. In some of these and some others, she kept her arm stiff in some way, that was hard to define, but that seemed to be mainly at the elbow. Both of these devices seemed to her to increase speed. The actual speed on these occasions was always fairly high, but not always at a maximum.

Subject E. General Discussion.

Subject E is a woman, aged twenty-six, who had had no previous practice at the test. The graphs of $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ show a fairly steep fall in score between the first trial and the second, and afterwards a gradual tendency to decrease, of which it is hard to say where it stops. The score $\frac{X_1 + X_2}{Y}$ appears to vary about an approximately constant level.

An interesting fact is, that an interval in the testing is almost always followed by a rise in the speed of X_2, and often by a fall in that of X_1, with the consequence that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ are practically always at a minimum after such an interval. It appears that the ability to write reversed ws consolidated itself in an interval, in the case of this subject; it did not do so to any noticeable degree in the case of any other. Snoddy[38] suggests, that improvement in the "adaptation" part of a learning curve may be due to growth, which would of course go on in an interval, but these improvements take place in what appears to be the "facilitation" part. Besides, they are not rises to a higher plateau, but fluctuations in the same plateau. The effect of intervals on the speed in Y varies, but the score $\frac{X_1 + X_2}{Y}$ usually rises after an interval.

There is some evidence for a connection between the/

the speed of X_2 , and the way in which the ws were written. They tended to be written closer together as the testing proceeded, and the rise to a higher plateau, at the twenty-eighth trial, corresponds roughly with the point, at which the practice of writing them very close together became established. In trial 36, at which the maximum speed in X_2 was reached, the reversed ws were grouped in threes, the members of each group being very close together. This suggests, that some rhythm which increased speed was perhaps achieved in this trial, and subsequently lost again.

Subject E gave no introspections.

Subject E. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
1	Ap:16	8.45 A.M.	30	18	51	.94	1.67	2.85	
2	Ap:17	8.30 A.M.	33	25	60	.97	1.32	2.42	
3	Ap:18	8.45 A.M.	35	27	64	.97	1.30	2.39	
4	Ap:19	8.45 A.M.	43	32	69	1.09	1.34	2.59	The increased speed may be because "as fast as possible" was said for the first time since the beginning.
5	Ap:20	8.55 A.M.	42	34	80	.95	1.24	2.29	
6	Ap:22	8.35 A.M.	42	34	80	.95	1.24	2.29	
7	Ap:23	8.45 A.M.	46	35	76	1.07	1.31	2.52	Barrel organ played just outside window during X_1
8	Ap:24	8.35 A.M.	46	34	82	.98	1.35	2.47	
9	Ap:25	8.40 A.M.	45	37	86	.95	1.22	2.27	
10	Ap:26	8.30 A.M.	44	35	82	.96	1.26	2.33	
11	Ap:27	8.45 A.M.	45	34	78	1.01	1.37	2.47	Clock struck in room during Y.
12	Ap:29	8.40 A.M.	47	42	90	.99	1.12	2.16	S. had slight cold.
13	Ap:30	8.45 A.M.	46	34	88	.91	1.35	2.40	Barrel organ played near window during X_1, X_2 and half of Y.
14	May 1	8.30 A.M.	45	35	82	.98	1.29	2.39	S. still had slight cold.
15	May 2	8.45 A.M.	47	34	81	1.00	1.38	2.54	
16	May 3	8.35 A.M.	47	35	83	.99	1.34	2.47	
17	May 4	8.55 A.M.	46	32	81 (4)	.96	1.44	2.58	S. began making ordinary ws in Y. She said this was due to her mind wandering.
18	May 6	8.35 A.M.	43	36	78	1.01	1.19	2.29	
19	May 7	8.45 A.M.	42	35	79	.97	1.20	2.26	S. very sleepy.

Subject E. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
20	May 8	8.45 A.M.	43	34	76	1.01	1.26	2.39	
21	May 9	8.50 A.M.	45	31	73	1.04	1.45	2.68	
22	May 10	8.30 A.M.	48	33	87	.93	1.45	2.55	
23	May 11	9.10 A.M.	48	34	86	.95	1.41	2.23	
24	May 13	8.35 A.M.	45	37	85	.96	1.22	2.28	
25	May 14	8.45 A.M.	46	38	95	.88	1.21	2.18	
(26	May 15	8.40 A.M.	52	34	95	.91	1.53	2.62)	S. up late the previous night, and very sleepy.
27	May 16	8.45 A.M.	49	37	93	.92	1.32	2.37	
28	May 17	8.45 A.M.	53	44	89	1.09	1.20	2.39	E. found after X_1 that S. had been counting her score and told her not to; she resented this a little.
29	May 18	8.45 A.M.	49	41	100	.90	1.20	2.18	
(30	May 20	8.55 A.M.	47	43	95	.95	1.09	2.08)	Discarded on the ground that the interval may have affected the score.
31	May 21	8.45 A.M.	50	43	97	.96	1.16	2.19	
32	May 22	8.40 A.M.	47	40	100	.87	1.175	2.115	
33	May 23	8.50 A.M.	48	45	94	.99	1.07	2.09	
34	May 24	8.35 A.M.	53	43	100	.96	1.23	2.29	
35	May 25	8.55 A.M.	51	41	99	.93	1.24	2.27	
(36	May 27	8.35 A.M.	48	51	100 (1)	.99	.94	1.90)	"p" error. Discarded on the ground that the interval may have affected the score.
37	May 28	9 A.M.	51	44	102	.93	1.16	2.16	

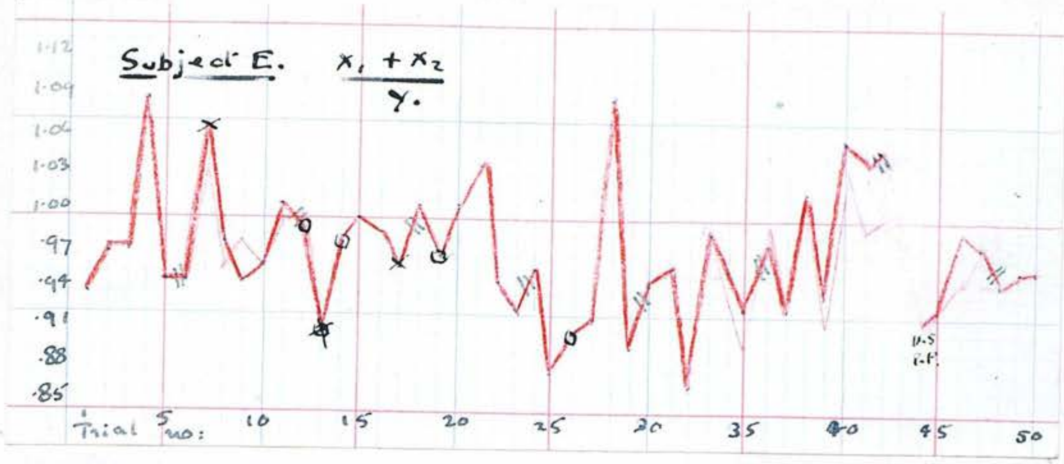
Subject E. Scores when all ws are counted as correct.

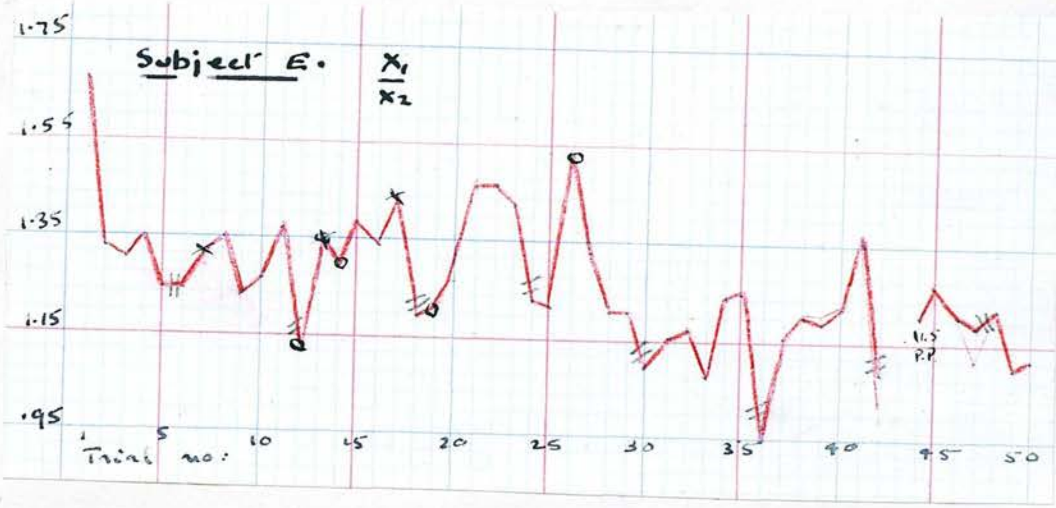
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
38	May 29	8.40 A.M.	51	43	92	1.02	1.19	2.30	
39	May 30	8.55 A.M.	52	44	102	.94	1.18	2.20	
40	May 31	8.40 A.M.	52	43	90	1.06	1.21	2.37	
41	June 1	9 A.M.	57	42	95	1.04	1.36	2.56	"p" error.
42	June 3	8.55 A.M.	53	49	(1) 97	1.05	1.08	2.17	
43	June 4	Result discarded owing to fault in procedure.							
(44	June 5	11.5 A.M.	49	41	98	.92	1.20	2.20)	Done with pressure pencil.
45	June 6	8.50 A.M.	48	38	92	.93	1.26	2.30	
46	June 7	9.5 A.M.	49	41	91	.99	1.20	2.28	
47	June 8	9.10 A.M.	52	44	98	.98	1.18	2.24	
48	June 10	9.5 A.M.	52	43	100	.95	1.21	2.25	
49	June 11	8.15 A.M.	50	46	100	.96	1.09	2.09	Before examination, about which S. appeared somewhat nervous.
50	June 12	8.20 A.M.	51	46	101	.96	1.11	2.12	Before examination.

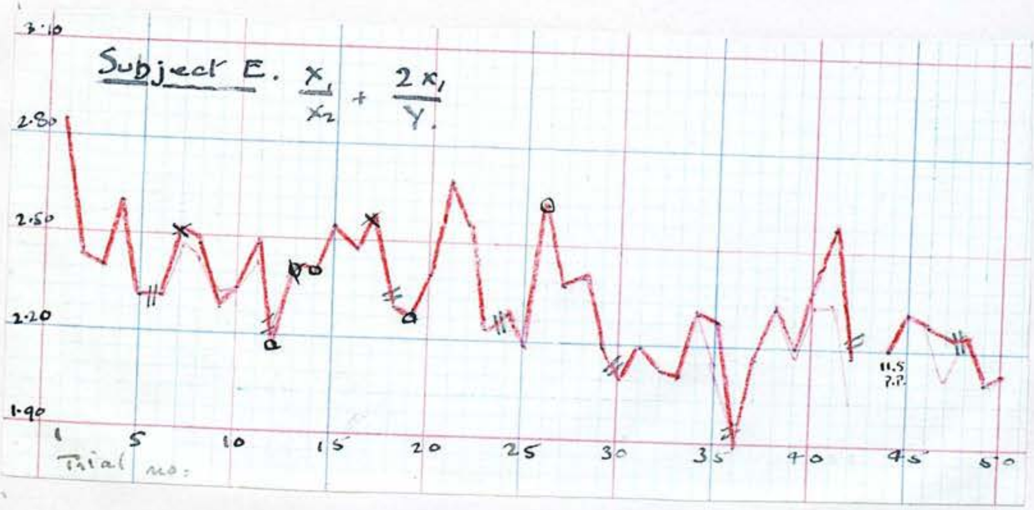
Subject E. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X}{X_2} + \frac{2X_1}{Y}$
7	45 (1)	35	76	1.05	1.29	2.47
8	45 (1)	34	82	.96	1.32	2.42
9	45	37	84 (2)	.98	1.22	2.29
11	44 (1)	34	78	1.00	1.29	2.42
12	47	42	89 (1)	1.00	1.12	2.18
35	48 (3)	41	99	.90	1.17	2.14
39	51 (1)	43 (1)	102	.92	1.19	2.19
40	51 (1)	43	90	1.04	1.19	2.32
41	52 (5)	42	95 (1)	.99	1.24	2.33
42	49 (4)	48 (1)	97	1.00	1.02	2.03
47	49 (3)	44	98	.95	1.11	2.11


Subject E. Speed.
Time of test 8.15 to 9.15 A.M. except where otherwise indicated.
P.P. 11.5
X1
X2
Trial no.
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
1
5
10
15
20
25
30
35
40
45
50


Subject E. $\frac{x_1 + x_2}{Y}$
1.12
1.09
1.06
1.03
1.00
.97
.94
.91
.88
.85
Trial no:
1
5
10
15
20
25
30
35
40
45
50
U.S.
P.P.


Subject E. $\frac{x_1}{x_2}$
1.75
1.55
1.35
1.15
.95
Trial no:
1
5
10
15
20
25
30
35
40
45
50
U.S.
P.P.


Subject E. $\frac{x_1}{x_2} + \frac{2x_1}{Y}$
3.10
2.80
2.50
2.20
1.90
Trial no:
1
5
10
15
20
25
30
35
40
45
50
U.S.
P.P.

Subject F. General Discussion.

Subject F is a woman, aged twenty-five, who had had no previous practice at the test. She is noteworthy for the great improvement in the speed of writing reversed ws, of which she wrote over three times as many in her last trial, as in her first.

It can be seen from the graphs, that the score $\frac{X_1}{X_2}$ drops rapidly at first, and more and more gradually till about the thirtieth trial. The curve of the score $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ is similar, but the decrease practically ceases at about the twentieth trial. The score $\frac{X_1 + X_2}{Y}$ varies about an approximately constant level.

Subject F appears to have been still improving in speed, in X_2 and Y, right up to the end of the testing, and it is possible that even in X_1 improvement may not have completely ceased.

After trial 15, S. was asked if she could account for the "perseverative" errors, made in the two previous trials, and replied that she was not aware of having made them, but that she knew she had made the one in trial 15 - she "fell over herself". Apart from this she gave only one or two short introspections.

Subject F. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
1	Ap:16	1.35 P.M.	35	16	51	1.00	2.19	3.56	S. said X_2 was very difficult.
2	Ap:17	Result discarded owing to fault in procedure.							
3	Ap:18	1.30 P.M.	41	26	70	.96	1.58	2.75	
4	Ap:19	1.35 P.M.	48	26	78	.95	1.85	3.08	
5	Ap:20	1.35 P.M.	51	31	84	.98	1.65	2.86	
6	Ap:22	1.25 P.M.	51	30	83	.98	1.70	2.93	S. said she till disliked X_2, and that it caused the same sensation as writing with her left hand.
7	Ap:23	1.30 P.M.	50	34	84	1.00	1.47	2.66	
8	Ap:24	1.45 P.M.	47	34	82	.99	1.38	2.53	
9	Ap:25	1.25 P.M.	52	35	78	1.12	1.49	2.82	
10	Ap:26	1.25 P.M.	54	35	90	.99	1.54	2.74	
11	Ap:27	1.25 P.M.	54	36	87	1.03	1.50	2.74	
12	Ap:29	1.30 P.M.	53	36	91	.98	1.47	2.63	
13	Ap:30	1.25 P.M.	53	38	89(1)	1.02	1.39	2.58	"p" error.
14	May 1	1.45 P.M.	53	37	84 (1)	1.07	1.43	2.69	"p" error.
15	May 2	1.30 P.M.	53	37	87 (1)	1.03	1.43	2.65	"p" error.
16	May 3	1.30 P.M.	55	40	94	1.01	1.375	2.545	
17	May 4	1.35 P.M.	54	40	96	.98	1.35	2.475	
(18	May 7	1.25 P.M.	53	40	98	.95	1.325	2.405)	Discarded on the ground that the interval may have affected the score.
19	May 8	2 P.M.	55	40	98	.97	1.375	2.495	S. had just been writing a great deal.

Subject F. Scores when all ws are counted as correct.

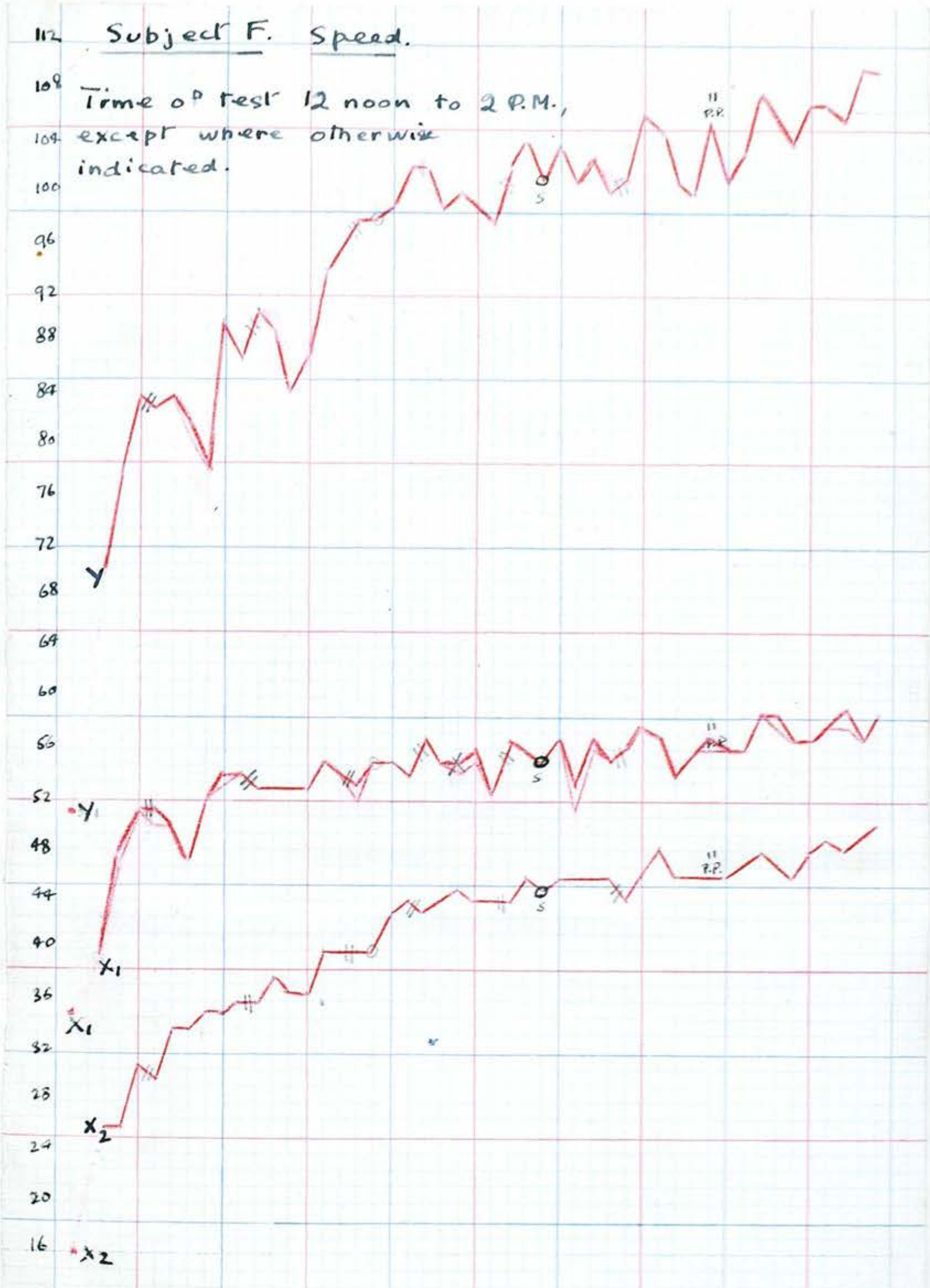
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
20	May 9	1.25 P.M.	55	43	99	.99	1.28	2.39	
21	May 10	1.25 P.M.	54	44	102	.96	1.23	2.29	
22	May 13	1.35 P.M.	57	43	102	.98	1.33	2.45	
23	May 14	1.20 P.M.	55	44	99	1.00	1.25	2.36	
24	May 15	1.50 P.M.	55	45	100	1.00	1.22	2.32	S. brushed a hair out of her eyes during X_1.
25	May 16	1.30 P.M.	56	44	99	1.01	1.27	2.40	S. expressed pleasure at having done more than on the previous day.
26	May 17	1.20 P.M.	53	44	98	.99	1.20	2.28	
27	May 21	1.35 P.M.	56	44	102	.98	1.27	2.37	
28	May 22	1.50 P.M.	56	46	104	.98	1.22	2.30	
29	May 23	1.25 P.M.	55	45	101	.99	1.22	2.31	S. said she was very tired indeed, and thought her score would be lower.
30	May 24	1.25 P.M.	57	46	104	.99	1.24	2.34	
31	May 25	1.25 P.M.	53	46	101	.98	1.15	2.20	
32	May 26	1.5 P.M.	57	46	103	1.00	1.24	2.35	
33	May 27	1.30 P.M.	55	46	100 (1)	1.01	1.20	2.30	"p" error.
34	May 31	1.45 P.M.	56	44	101	.99	1.27	2.38	On smaller paper.
35	June 1	1 P.M.	58	46	106	.98	1.26	2.35	
36	June 2	1.20 P.M.	57	48	105	1.00	1.19	2.28	35 secs: between X_2 and Y.
37	June 3	1.45 P.M.	54	46	101	.99	1.17	2.24	
38	June 4	12.30 P.M.	56	46	100	1.02	1.22	2.24	40 secs: between X_2 and Y.

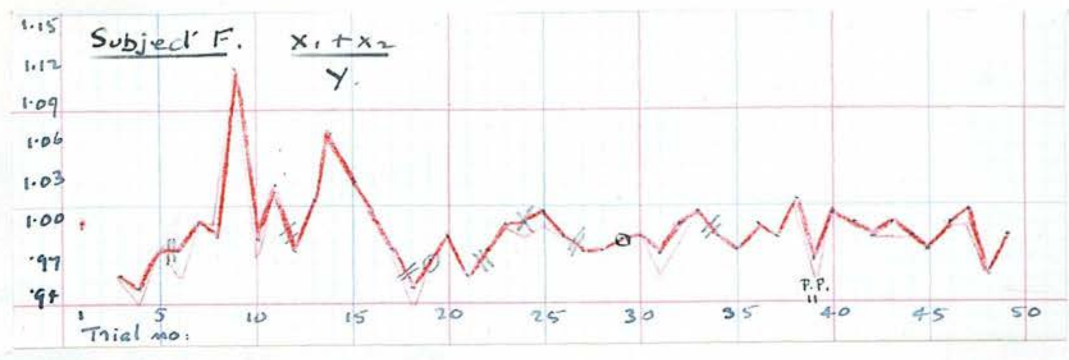
Subject F. Scores when all ws are counted as correct.

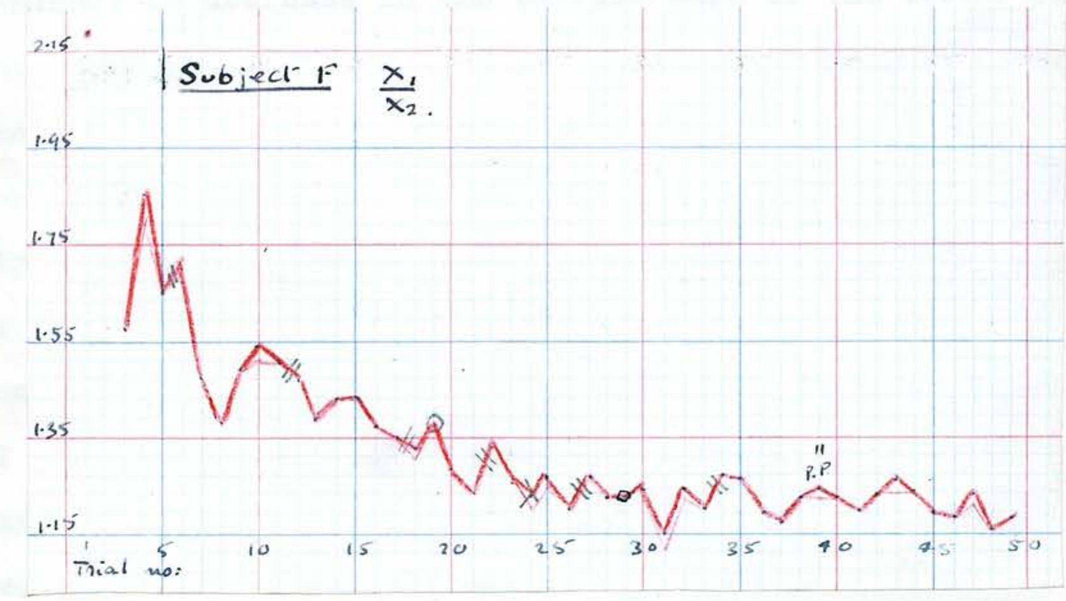
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
(39	June 5	11 A.M.	57	46	106	.97	1.24	2.32)	Done with pressure pencil.
40	June 6	1.40 P.M.	56	46	101	1.01	1.22	2.33	
41	June 7	1.45 P.M.	56	47	103	1.00	1.19	2.28	
42	June 8	1.10 P.M.	59	48	108	.99	1.23	2.32	S. expressed pleasure at having reached the seventh line in X_1.
43	June 9	1.20 P.M.	59	47	106	1.00	1.26	2.37	
44	June 10	1.45 P.M.	57	46	104	.99	1.24	2.34	
45	June 11	12.55 P.M.	57	48	107	.98	1.19	2.26	Test done between two examinations.
46	June 12	12.40 P.M.	58	49	107	1.00	1.18	2.26	Test done between two examinations.
47	June 13	12.45 P.M.	59	48	106	1.01	1.23	2.34	Test done between two examinations.
48	June 14	12.50 P.M.	57	49	110	.96	1.16	2.20	Test done between two examinations.
49	June 15	12.40 P.M.	59	50	110	.99	1.18	2.25	Test done between examination and hearing results.

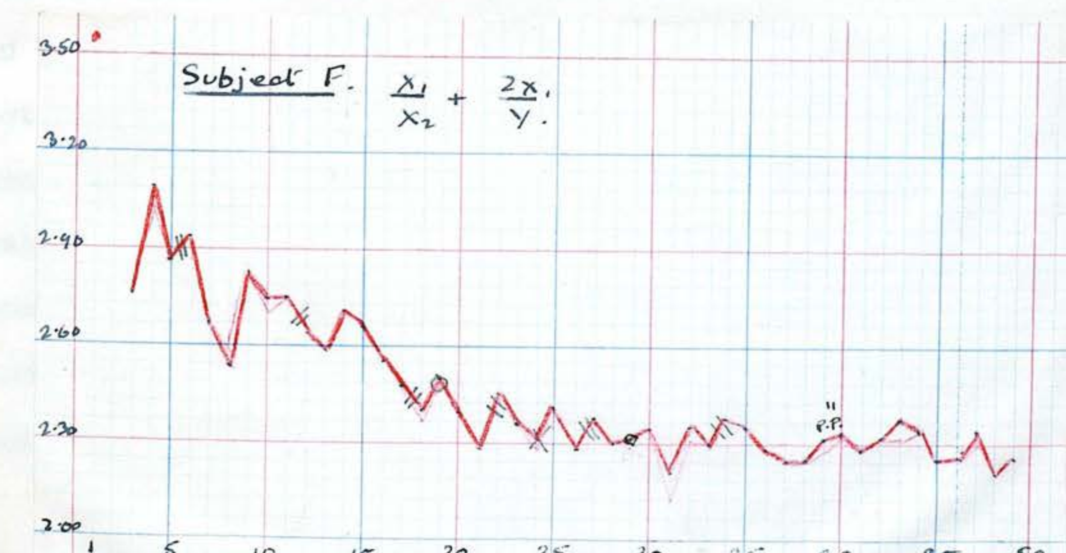
Subject F. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
4	47 (1)	26	78	.94	1.81	3.02
6	50 (1)	30	83	.96	1.67	2.87
8	47	34	81 (1)	1.00	1.38	2.54
10	53 (1)	35	90	.98	1.51	2.69
(18	52 (1)	40	98	.94	1.30	2.36)
24	54 (1)	45	100	.99	1.20	2.28
25	55 (1)	44	99	1.00	1.25	2.36
31	51 (2)	46	101	.96	1.11	2.12
32	56 (1)	46	103	.99	1.22	2.31
(39	56 (1)	46	106	.96	1.22	2.28)
43	58 (1)	47	106	.99	1.23	2.32
47	58 (1)	48	106	1.00	1.21	2.30


Subject F. Speed.
Time of test 12 noon to 2 P.M., except where otherwise indicated.
112
108
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
Y
X1
X2
S
P.P.
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject F.
X₁ + X₂ / Y.
1.15
1.12
1.09
1.06
1.03
1.00
·97
·94
P.P.
1 5 10 15 20 25 30 35 40 45 50
Trial no:


Subject F
X₁ / X₂.
2.15
1.95
1.75
1.55
1.35
1.15
P.P.
1 5 10 15 20 25 30 35 40 45 50
Trial no:


Subject F.
X₁ / X₂ + 2X₁ / Y.
3.50
3.20
2.90
2.60
2.30
2.00
P.P.
1 5 10 15 20 25 30 35 40 45 50
Trial no:

Subject G. General Discussion.

Subject G is a woman, aged twenty-three, who had done ten previous trials at the test, at her natural pace, in Experiment II.

The scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ show only a slight tendency to decrease in the earlier part of the testing, while $\frac{X_1 + X_2}{Y}$ fluctuates about a constant level. The speed tended to decrease towards the end of the period of testing, at any rate in X_2 and Y. This might possibly have been due to boredom, but there is no evidence as to its cause, as G gave very few introspections. The loss of speed between Experiment II and Experiment III is greatest in X_2. The day to day variability of the perseveration scores tends to decrease towards the end of the experiment.

S. was asked on May 3rd, if she could account for the first of the two "perseverative" errors, made on the previous day. She said she could not; she did not realise at once that she had made it. She remembered, however, that she had looked back at the beginning of the line, in which it occurs, to see if she had finished the last line with a reversed **w** . Possibly the wandering of attention involved in doing this may have caused it.

Interruptions by noise and intervals in the testing appear to have no consistent effect on speed.

Subject G. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov.12	10-11 A.M.	30	22	47	1.11	1.36	2.64	
2	"	"	37	26	59	1.07	1.42	2.67	
3	Nov:19	"	39	27	67	.99	1.44	2.60	
4	"	"	44	30	78	.95	1.47	2.60	
5	"	"	45	34	74	1.07	1.32	2.54	
6	Nov:26	"	43	31	71	1.04	1.39	2.60	
7	"	"	46	36	86	.95	1.28	2.35	
8	Dec.3	"	45	30	76	.99	1.50	2.68	
9	"	"	46	35	72	1.125	1.31	2.59	32 secs: between X_2 and Y.
10	"	"	43	39	77	1.06	1.10	2.22	32 secs: between X_2 and Y.
Experiment III.									
1	Ap:16	9.50 A.M.	39	28	72	.93	1.39	2.47	
2	Ap:17	"	39	30	74	.93	1.30	2.35	
3	Ap:18	9.55 A.M.	47	38	86	.99	1.24	2.33	
4	Ap:19	"	47	40	91	.96	1.175	2.205	
5	Ap:22	"	48	43	93	.98	1.12	2.15	Noise in X_1 and at the end of Y.
6	Ap:23	9.50 A.M.	47	34	79	1.03	1.38	2.57	Before the test S. was criticised for making errors.
7	Ap:24	"	43	39	80	1.025	1.10	2.175	
8	Ap:25	"	42	38	80	1.00	1.11	2.16	Noise in X_2.
9	Ap:26	"	47	36	84	.99	1.31	2.43	Before the test S. was told that the scoring was to be more lenient.

Subject G. Score when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
10	Ap:29	9.50 A.M.	39	36	74	1.01	1.08	2.18	
11	Ap:30	9.55 A.M.	43	38	83	.98	1.13	2.17	
12	May 1	"	44	35	82	.96	1.26	2.33	
13	May 2	"	45	36	78	1.07	1.25	2.43	Two "p" errors.
14	May 3	"	47	32	77	1.04	1.47	2.71	One "p" error.
15	May 6	8.55 A.M.	48	42	82	1.10	1.14	2.31	
16	May 7	9.55 A.M.	44	42	83	1.04	1.05	2.11	S. up later than usual the previous night. Door banged during Y.
17	May 8	"	45	43	90	.98	1.05	2.05	
18	May 9	10 A.M.	45	45	96	.94	1.00	1.94	Noise during Y.
19	May 10	"	46	43	93	.96	1.07	2.06	Knock on door during X_1. and slight noise during X_2.
20	May 13	Discarded owing to fault in procedure.							
21	May 14	10 A.M.	45	44	83	1.07	1.02	2.10	Noise during Y.
(22	May 15	"	46	40	80	1.075	1.15	2.30)	Noise during X_2.
23	May 16	"	45	41	89	.97	1.10	2.11	
24	May 17	9.55 A.M.	44	38	82	1.00	1.16	2.23	
25	May 20	10 A.M.	41	36	80	.96	1.14	2.165	
26	May 21	"	42	43	87	.98	.98	1.95	
27	May 22	9.50 A.M.	44	39	93	.89	1.13	2.08	35 secs: between X_2 and Y.
28	May 23	9.55 A.M.	41	43	84	1.00	.95	1.93	
29	May 24	9.50 A.M.	43	40	86	.97	1.075	2.075	
(30	May 27	10 A.M.	48	37	83	1.02	1.30	2.46)	Noise in Y.
31	May 28	"	40	36	82	.93	1.11	2.09	

Subject G. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
32	May 29	10 A.M.	44	35	88	.90	1.26	2.26	
33	May 30	"	40	40	86	.93	1.00	1.93	
34	May 31	9.55 A.M.	40	38	82	.95	1.05	2.03	
35	June 3	"	44	39	83	1.00	1.13	2.19	
36	June 4	"	44	42	85	1.01	1.05	2.09	Noise in Y.
37	June 5	10 A.M.	42	42	93	.90	1.00	1.90	
38	June 6	9.55 A.M.	46	45	85	1.07	1.02	2.10	Noise in Y.
39	June 7	11.40 A.M.	43	41	83	1.01	1.05	2.09	Done before examination. Slight noise in X_1.
40	June 11	11.5 A.M.	39	39	80	.975	1.00	1.975	Done after examination.
41	June 12	10 A.M.	44	39	86	.97	1.13	2.15	
42	June 13	9.55 A.M.	45	40	80	1.06	1.125	2.25	
43	June 14	10 A.M.	42	37	80	.99	1.14	2.19	
44	June 17	"	40	37	79	.98	1.08	2.09	
(45	June 18	10.10 A.M.	42	36	82	.95	1.17	2.19)	Done with pressure pencil.
46	June 19	10 A.M.	42	35	76	1.01	1.20	2.31	
47	June 20	"	41	37	76	1.03	1.11	2.19	
48	June 21	10.15 A.M.	40	36	76	1.00	1.11	2.16	
49	June 24	10.5 A.M.	40	38	76	1.03	1.05	2.10	Interruption at end of X_1, from someone speaking to E. S. was shown her results after the test.
50	June 25	9.55 A.M.	41	36	76	1.01	1.14	2.22	

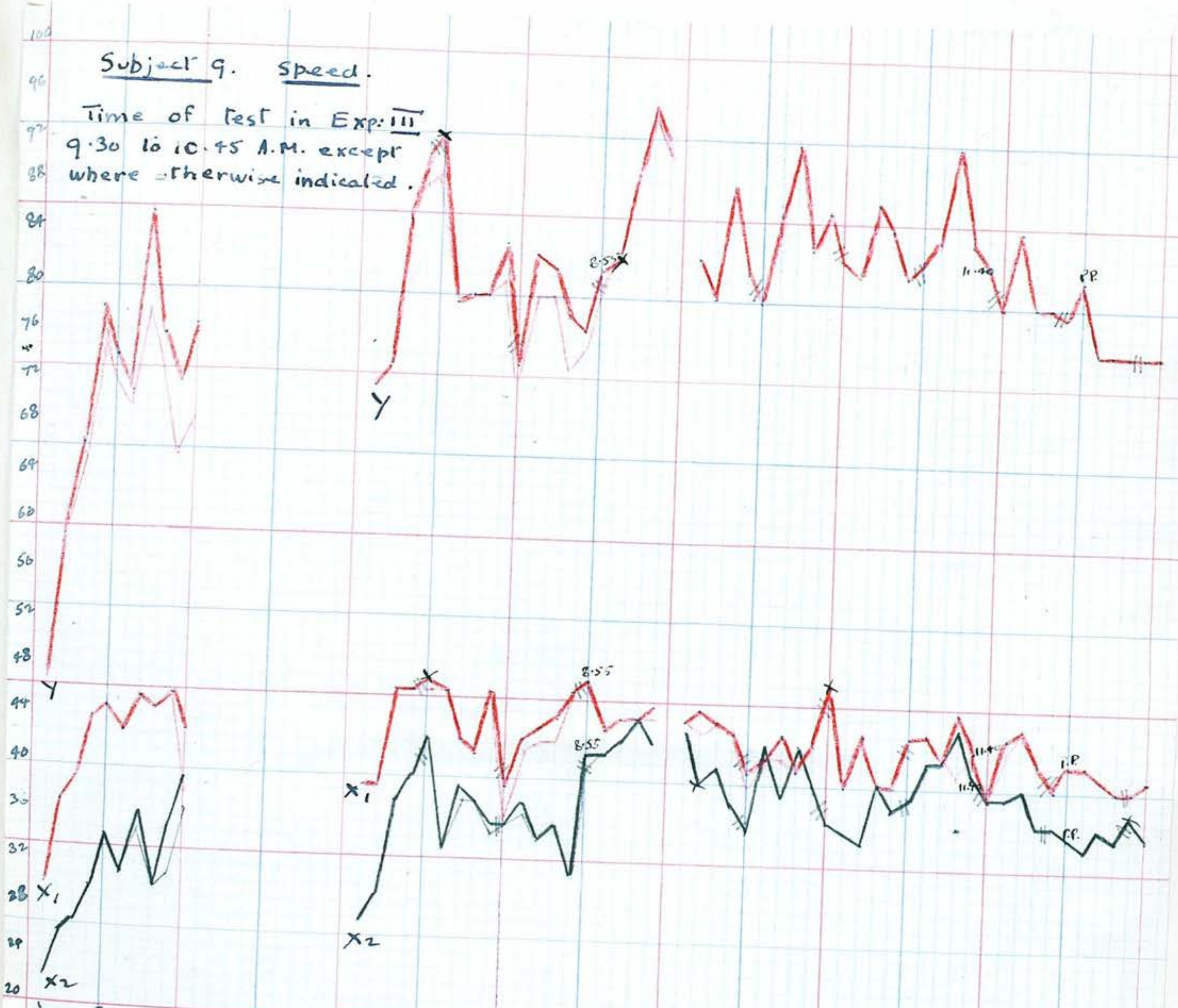
Subject G. Changes in score when imperfect ws are counted as errors.

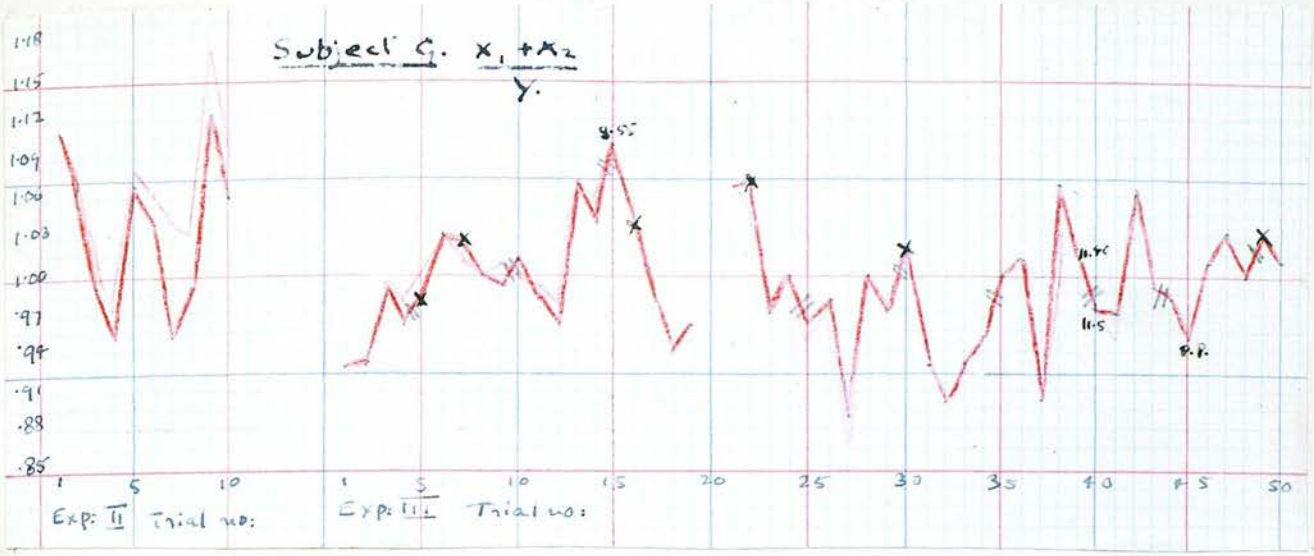
Experiment II.

Trial No.	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$
3	39	27	66 (1)	1.00	1.44	2.62
4	44	30	76 (2)	.97	1.47	2.63
5	45	34	73 (1)	1.08	1.32	2.55
6	43	31	70 (1)	1.06	1.39	2.62
7	46	35 (1)	78 (8)	1.04	1.31	2.49
8	45	30	73 (3)	1.03	1.50	2.73
9	46	31 (4)	66 (6)	1.17	1.48	2.87
10	38 (5)	37 (2)	69 (8)	1.09	1.03	2.13

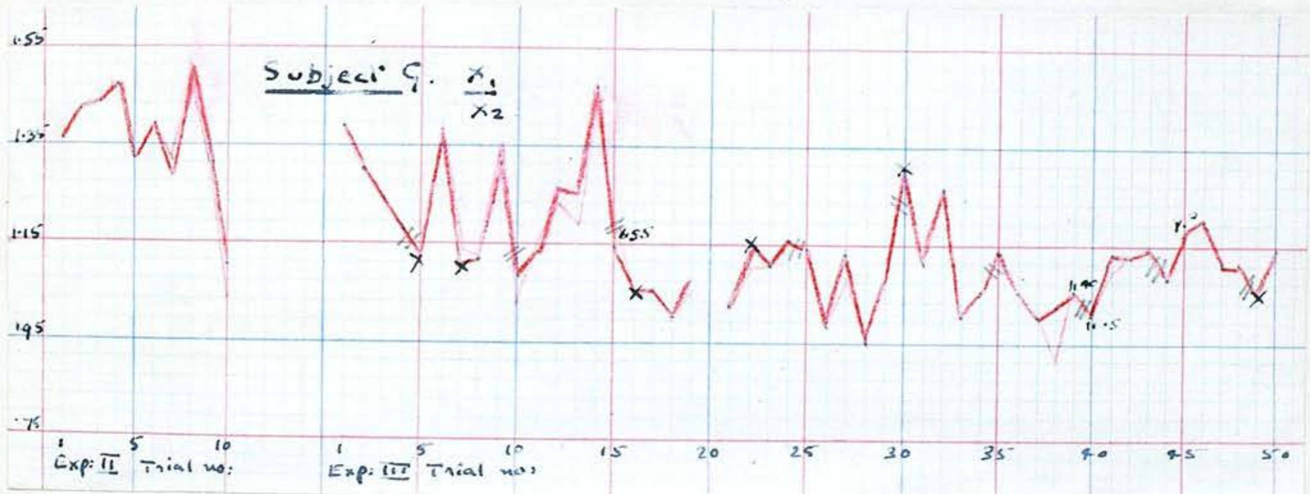
Experiment III.

Trial No.	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$
4	47	40	89 (2)	.98	1.175	2.235
5	47 (1)	43	90 (3)	1.00	1.09	2.13
7	43	38 (1)	80	1.01	1.13	2.205
9	47	35 (1)	81 (3)	1.01	1.34	2.50
10	37 (2)	36	73 (1)	1.00	1.03	2.04
11	42 (1)	37 (1)	80 (3)	.99	1.14	2.19
12	43 (1)	35	80 (2)	.975	1.23	2.305
13	43 (2)	36	74 (4)	1.07	1.19	2.35
14	47	32	75 (2)	1.05	1.47	2.72
15	48	41 (1)	81 (1)	1.10	1.17	2.36
19	45 (1)	43	92 (1)	.96	1.05	2.03
(22	44 (2)	40	80	1.05	1.10	2.20)
25	40 (1)	36	80	.95	1.14	2.11
27	42 (2)	39	93	.87	1.08	1.98
38	41 (5)	45	85	1.01	.91	1.87
41	43 (1)	39	86	.95	1.10	2.10

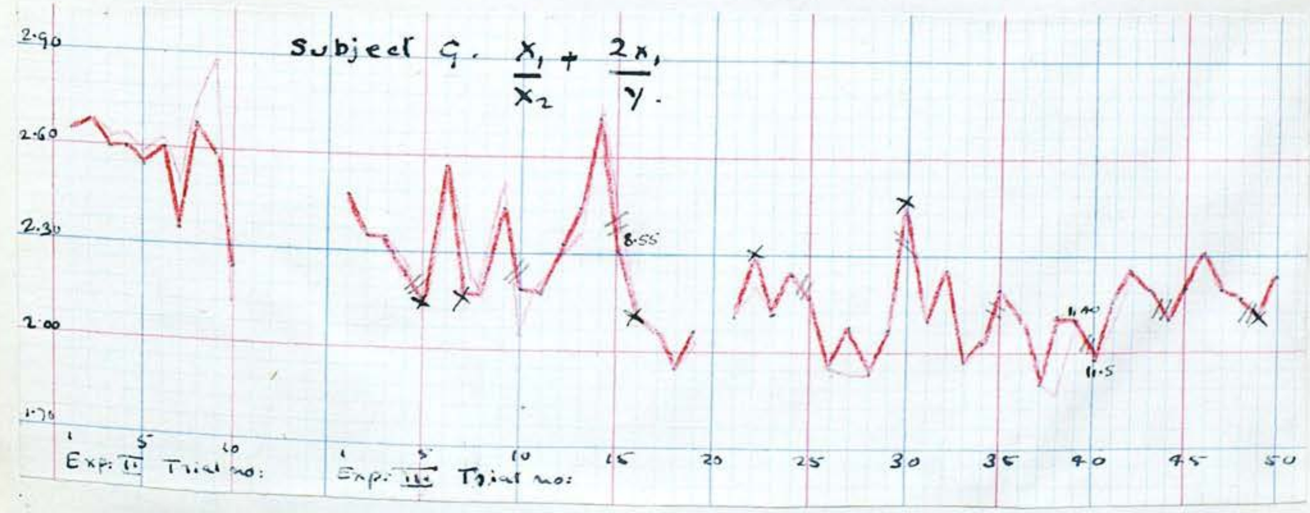

Subject 9. Speed.
Time of test in Exp: III
9.30 to 10.45 A.M. except
where otherwise indicated.
Y
X1
X2
8.55
11.40
P.P.
Experiment II. Trial no:
Experiment III Trial no:



Subject G. $\frac{x_1 + x_2}{y}$.
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
·91
·88
·85
Exp: II Trial no:
Exp: III Trial no:



Subject G. $\frac{x_1}{x_2}$
1·55
1·35
1·15
·95
·75
Exp: II Trial no:
Exp: III Trial no:



Subject G. $\frac{x_1}{x_2} + \frac{2x_1}{y}$.
2·90
2·60
2·30
2·00
1·70
Exp: II Trial no:
Exp: III Trial no:

Subject H. General Discussion.

Subject H is G's sister, aged twenty-one. She had had no previous practice at the test. The difference between the mean perseveration scores of these two sisters is the more striking, because, to a superficial observer, they appear very much alike in personality. Both are shy, and they are similar in manner and speech. The difference in question is, of course, immediately due in all probability to the form of reversed w used, but one wonders, whether the difference in the form of the w reveals some deep difference in personality. The handwriting of these two sisters is different.

The form of reversed w used by H varied during the period of testing. In the first three trials, the reversed ws are tilted in a backhand direction, and are nearly all rounded. Then there is a great deal of irregularity, till the angular form, tilted in a forehand direction, is established by the ninth trial. The tilt tends to increase for a time; from about trial 27 it decreases and the ws are sometimes rounded. From about the fortieth trial, they are mostly rounded and upright, till the last trial, when they are again tilted in a backhand direction. It is tempting to connect the two forms of reversed w with the two maxima in the distribution of the scores $\frac{X_1 + X_2}{Y}$ but the evidence is scarcely sufficient to justify/

justify this.

The scores $\frac{X_1 + X_2}{Y}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ tended to increase during the period of testing, while $\frac{X_1}{X_2}$ fluctuated about an approximately constant level. This is unusual. It means that while ability to form the ordinary **w** and ability to form the reversed **w** increased at an approximately equal rate, ability to alternate the two did not increase so fast, but no reason for the latter fact can be suggested.

Interruptions by noise, and intervals in the testing appear to have produced no constant effect on the score. In trial 43, which was preceded by a period of rapid writing, the speed in X_1 was the highest ever reached, that in Y was fairly high, and that in X_2 rather low.

Subject H gave only a few short introspections.

Subject H. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
1	Ap:16	9.50 A.M.	28	22	52	.96	1.27	2.35	
2	Ap:17	"	30	21	64	.80	1.43	2.37	
3	Ap:18	9.55 A.M.	36	26	56	1.11	1.38	2.67	
4	Ap:19	"	41	30	72	.99	1.37	2.51	
5	Ap:20	11.40 A.M.	44	31	79	.95	1.42	2.53	
6	Ap:23	9.50 A.M.	43	31	77	.96	1.39	2.51	
7	Ap.24	"	43	32	77	.97	1.34	2.46	Noise at beginning of X_2.
8	Ap:25	"	45	30	69	1.09	1.50	2.84	
9	Ap:26	"	43	28	67	1.06	1.54	2.82	
10	Ap:29	"	43	35	83	.94	1.23	2.27	
11	Ap:30	9.55 A.M.	45	32	81	.95	1.41	2.52	
12	May 1	"	45	37	77	1.06	1.22	2.39	
13	May 2	"	46	38	82	1.02	1.21	2.33	
14	May 3	"	46	37	80	1.04	1.24	2.39	
15	May 6	8.55 A.M.	45	36	80	1.01	1.25	2.375	
16	May 7	9.55 A.M.	47	37	83	1.01	1.27	2.40	S. up later than usual last night. Door banged in Y.
17	May 8	"	45	33	78	1.00	1.36	2.51	
18	May 9	10 A.M.	46	34	76	1.05	1.35	2.56	Noise during Y.
19	May 10	"	45	36	81	1.00	1.25	2.36	Knock on door in X_1 and slight noise in X_2
20	May 13	Discarded owing to fault in procedure.							
21	May 14	10 A.M.	44	36	79	1.01	1.22	2.33	Noise in Y.
22	May 15	"	44	36	70	1.14	1.22	2.48	Noise in X_2
23	May 16	9.55 A.M.	47	35	72	1.14	1.34	2.65	

Subject H. Scores when all ws are counted as correct.

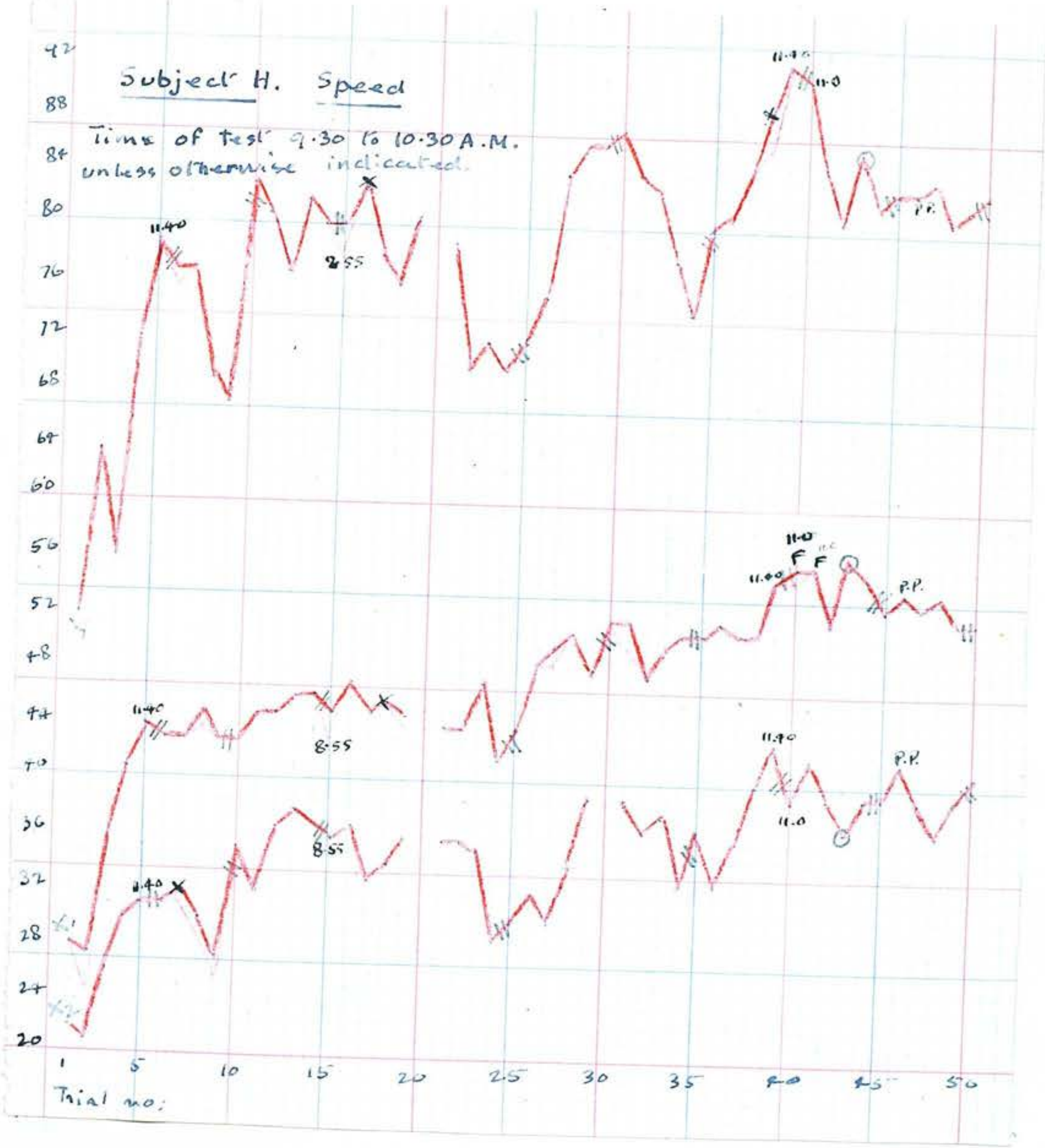
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
24	May 17	9.55 A.M.	42	29	70	1.01	1.45	2.65	
25	May 20	10 A.M.	44	30	72(1)	1.03	1.47	2.69	"p" error.
26	May 21	"	49	32	75	1.08	1.53	2.84	
27	May 22	9.50 A.M.	50	30	84	.95	1.67	2.86	35 secs. between X_1 and X_2.
28	May 23	9.55 A.M.	51	34	86	.99	1.50	2.69	
29	May 24	9.50 A.M.	48	39	86	1.01	1.23	2.35	S. remarked, that she had been making her reversed ws smaller for the last few days, as she had. Slight noise in X_2
(30	May 27	9.55 A.M.	52	19 (19)	87	-	-	-)	S. made alternating ws throughout X_2. She realised it at the end of the second line and paused. E. said "Just go on" expecting her now to make reversed ws, but she went on with alternating ones. She seemed flustered, perhaps because she was in danger of being late for a lecture.
31	May 28	10 A.M.	52	39	84	1.08	1.33	2.57	
32	May 29	9.50 A.M.	48	37	83	1.02	1.30	2.46	
33	May 30	10 A.M.	50	38	78	1.13	1.32	2.60	
34	May 31	9.55 A.M.	51	33	74	1.14	1.55	2.93	
35	June 3	"	51	37	80	1.10	1.38	2.655	

Subject H. Scores when all ws are counted as correct.

Trial No.	Date	Time	X1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
36	June 4	9.55 A.M.	52	33	81	1.05	1.58	2.86	Noise in X_2 and Y.
37	June 5	10 A.M.	51	36	85	1.02	1.42	2.62	
38	June 6	9.55 A.M.	51	40	89	1.02	1.275	2.425	Noise in Y.
39	June 7	11.40 A.M.	55	43	92	1.07	1.28	2.48	Test done before examination.
40	June 10	11 A.M.	56	39	91	1.04	1.44	2.67	S. had just come from examination, but had not been writing very fast.
41	June 11	10 A.M.	56	42	85	1.15	1.33	2.65	S. said she felt she was doing more ordinary ws on June 10th and 11th than previously.
42	June 12	10 A.M.	52	39	81	1.12	1.33	2.61	
43	June 13	11.10 A.M.	57	37	86	1.09	1.54	2.87	Done after examination, at which S. had been writing very fast.
44	June 14	10 A.M.	55	39	82	1.15	1.41	2.75	
45	June 17	"	53	39	83	1.11	1.36	2.64	
(46	June 18	9.55 A.M.	54	42	83	1.16	1.29	2.59)	Done with pressure pencil.
									S. said she felt that the difficulty was at the last upstroke of the reversed w.
47	June 19	10 A.M.	53	39	84	1.10	1.36	2.62	
48	June 20	"	54	37	81	1.12	1.46	2.79	"p" error.
49	June 21	10.15 A.M.	52	39	82	1.11	1.33	2.60	Interruption at end of X_2
									from someone speaking to E.
50	June 24	10.5 A.M.	52	41	83	1.12	1.27	2.52	

Subject H. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
2	25 (2)	21	64	.72	1.19	1.97
6	43	31	76 (1)	.97	1.39	2.52
7	43	31 (1)	77	.96	1.39	2.51
8	44 (1)	29 (1)	69	1.06	1.52	2.79
9	43	27 (1)	67	1.04	1.59	2.87
15	43 (2)	36	78 (2)	1.01	1.19	2.29
19	44 (1)	36	81	.99	1.22	2.31
27	49 (1)	30	84	.94	1.63	2.80
31	50 (2)	39	84	1.06	1.26	2.45
38	51	40	86 (3)	1.06	1.275	2.465
40	55 (1)	39	91	1.03	1.41	2.62


Subject H. Speed
Time of test 9.30 to 10.30 A.M.
unless otherwise indicated.
11.40
8.55
11.0
P.P.
F F
Trial no:
1
5
10
15
20
25
30
35
40
45
50
20
24
28
32
36
40
44
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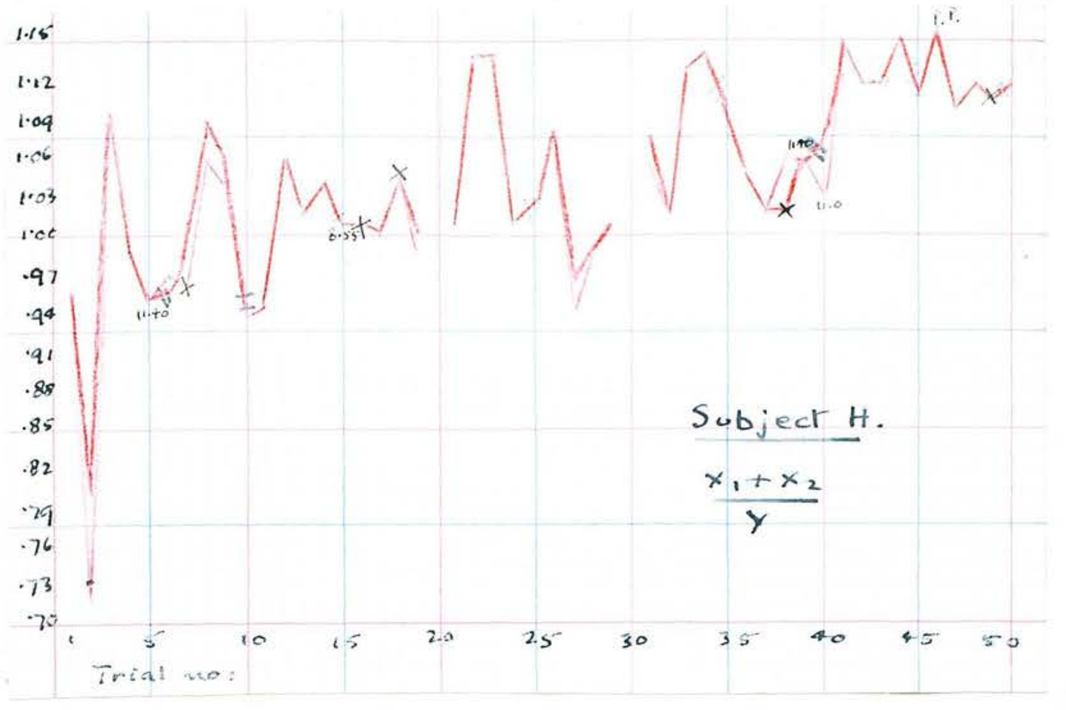
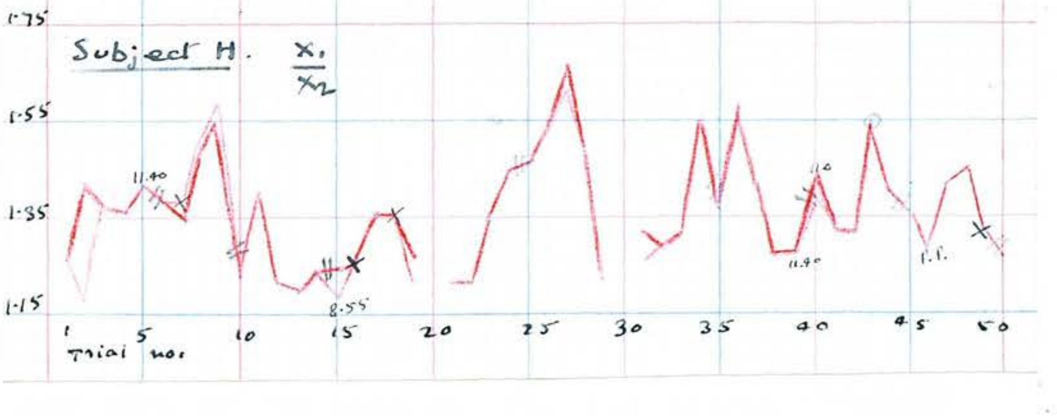
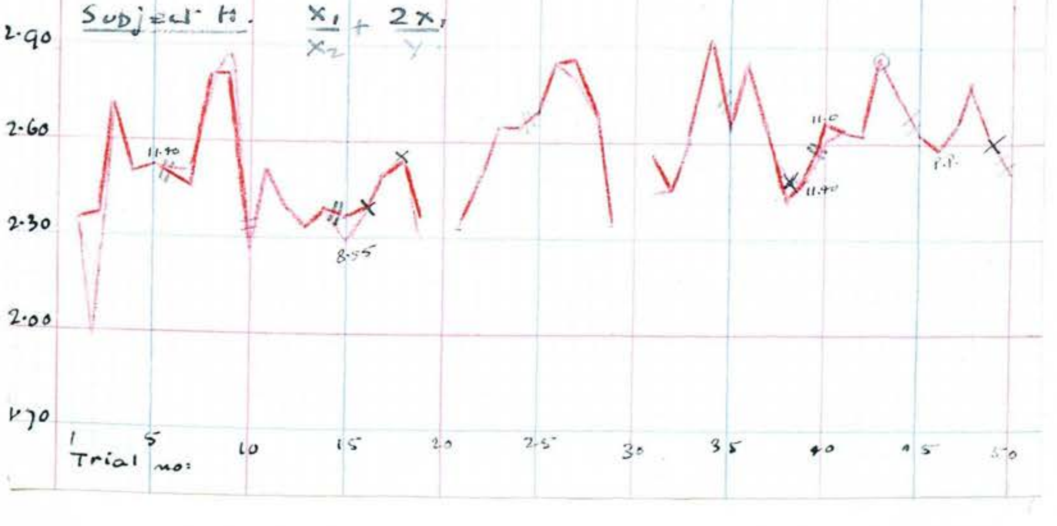
76
80
84
88
92


Subject H.
$\frac{x_1 + x_2}{y}$
Trial no:
1.15
1.12
1.09
1.06
1.03
1.00
.97
.94
.91
.88
.85
.82
.79
.76
.73
.70


Subject H. $\frac{x_1}{x_2}$
Trial no:
1.75
1.55
1.35
1.15


Subject H. $\frac{x_1}{x_2} + \frac{2x_1}{y}$
Trial no:
2.90
2.60
2.30
2.00
1.70

Subject I. General Discussion.

Subject I is a man, aged twenty-one, who had had no previous practice at the test. It has been already said, that he allowed his ws to degenerate into little wavy or bent lines. By doing this he was enabled to improve his speed very greatly in all the parts of the test; the rate of improvement was just beginning to slacken towards the end of the period of testing.

The graphs show that, when all ws are counted as correct, the perseveration score tends to fall gradually, at least as far as the twenty-fifth trial when the methods of scoring $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ are used, and throughout the testing when the scoring $\frac{X_1 + X_2}{Y}$ is used. A possible explanation of the fact, that the score is usually less than unity in the latter part of the testing, for the scores $\frac{X_1 + X_2}{Y}$ and $\frac{X_1}{X_2}$, and less than two for the scoring $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, is that accuracy is more easily sacrificed for the sake of speed in a newly acquainted activity. The general impression is certainly that Subject I's reversed ws are worse than his ordinary ones. When imperfect ws are counted as errors, the scores became meaningless in the later trials, and will not be given after the twentieth trial.

Subject I gave only a few short introspections.

Subject I. Score when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
1	Ap:16	10.5 A.M.	40	30	60	1.17	1.33	2.67	
2	Ap:17	10.10 A.M.	43	30	68	1.07	1.43	2.69)	Before these tests S. was criticised for his errors.
3	Ap:18	10.5 A.M.	50	37	88	.99	1.35	2.49)	
4	Ap:19	"	48	39	91	.96	1.23	2.28)	
5	Ap:20	12.35 A.M.	55	45	105	.95	1.22	2.27	
6	Ap:22	10.10 A.M.	56	40	96	1.00	1.40	2.57	Before the test E. criticised S. for his errors, saying that the fault was the absence of the middle division of the w. After it he said he had made them bigger. Interruption in Y.
7	Ap:23	10.5 A.M.	59	44	99	1.04	1.34	2.53	Interruption in Y from some-one speaking to E.
8	Ap:24	"	55	47	105	.97	1.17	2.22	
9	Ap:25	"	56	47	111	.93	1.19	2.20	Before the test S. was critic-ised for his errors.
10	Ap:26	"	63	48	105	1.06	1.31	2.51	Before the test S. was told that the scoring was to be more lenient, so that he need not trouble about his ws as long as they had a hook.
11	Ap:29	10.5	63	46	110	.99	1.37	2.52	
12	Ap:30	"	64	51	118	.97	1.25	2.33	
13	May 1	"	64	56	121	.99	1.14	2.20	
14	May 2	10	67	56	128	.96	1.20	2.25	

Subject I. Scores when all ws are counted as correct.

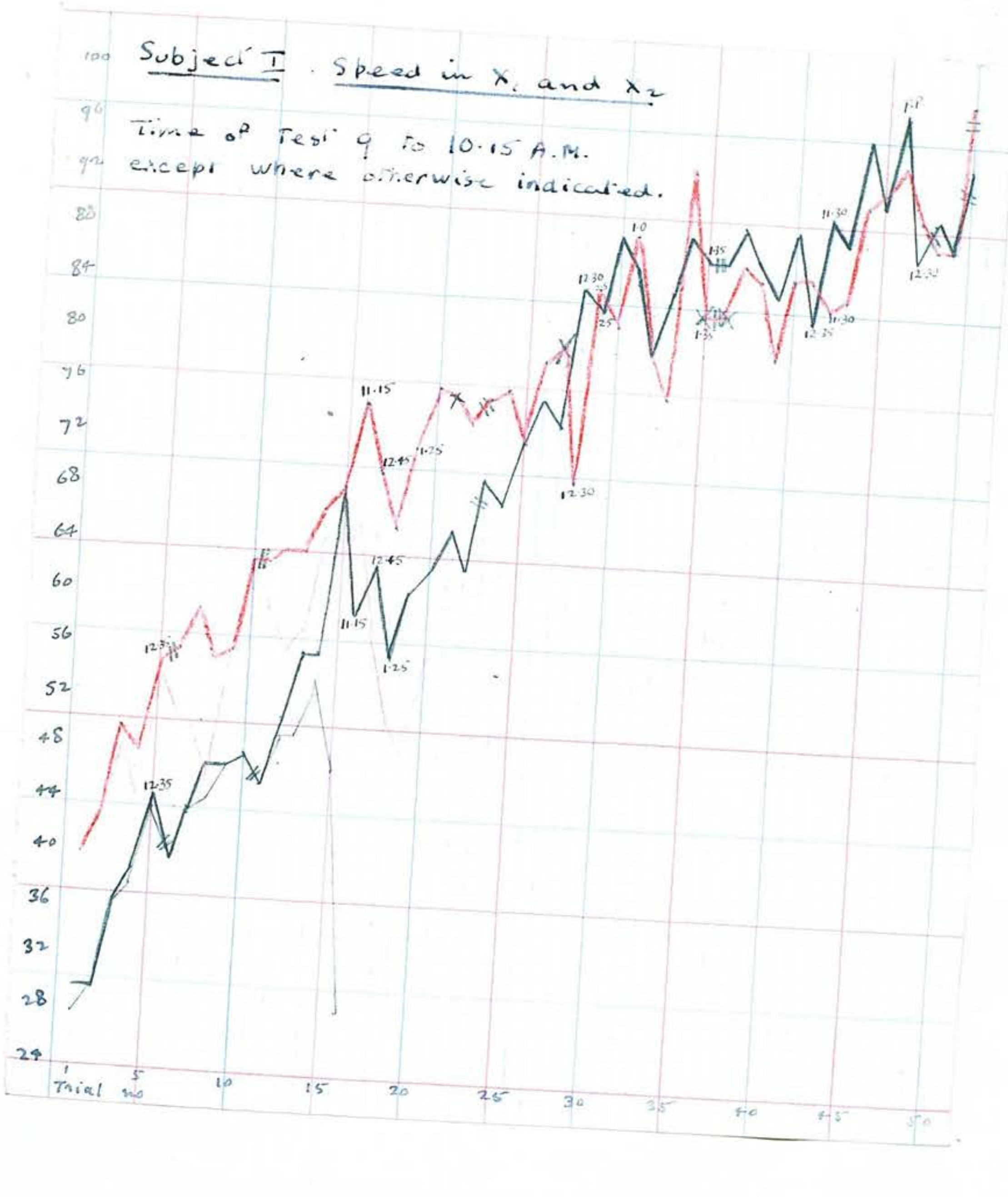
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
15	May 3	10.5 A.M.	69	69	127	1.09	1.00	2.09	
(16	May 4	11.15 A.M.	75	59	130	1.03	1.27	2.42)	Discarded on the ground that the later hour may have affected the score.
17	May 5	12.45 P.M.	70	63	131	1.02	1.11	2.18	Timed at home.
18	May 6	1.25 P.M.	66	56	132	.92	1.18	2.18	" " "
19	May 7	10.5 A.M.	72	61	130	1.02	1.18	2.29	S. was told he must not count his score; he had done so several times. He was up later than usual the previous night.
20	May 8	10.5 A.M.	77	63	143	.98	1.22	2.30	
21	May 9	"	76	66	147	.97	1.15	2.18	Door banged during X_1.
22	May 10	"	74	63	136	1.01	1.17	2.26	
23	May 13	"	76	70	150	.97	1.09	2.10	
24	May 14	"	77	68	156	.93	1.13	2.12	
25	May 15	10.10 A.M.	73	73	151	.97	1.00	1.97	
26	May 16	"	79	76	161	.96	1.04	2.02	
27	May 17	10.5 A.M.	80	74	161	.96	1.08	2.07	
(28	May 18	12.30 P.M.	70	85	168	.92	.82	1.65)	S's pencil broke during X_1
29	May 19	2.5 P.M.	85	83	178	.94	1.02	1.98	Timed at home.
30	May 20	10.15 A.M.	82	89	173	.99	.92	1.87	" " "
(31	May 21	1 P.M.	89	86	170	1.03	1.03	2.08)	" " "
32	May 22	10.5 P.M.	80	80	176	.91	1.00	1.91	
33	May 23	"	77	85	180	.90	.91	1.77	
34	May 24	10.10 A.M.	94	89	190	.96	1.06	2.05	
(35	May 25	12.35 P.M.	83	87	184	.92	.95	1.85	S's pencil broke during X_1.
(36	May 27	10.5 A.M.	83	87	190	.89	.95	1.82	S. screwed up his pencil (Eversharp) during X_1

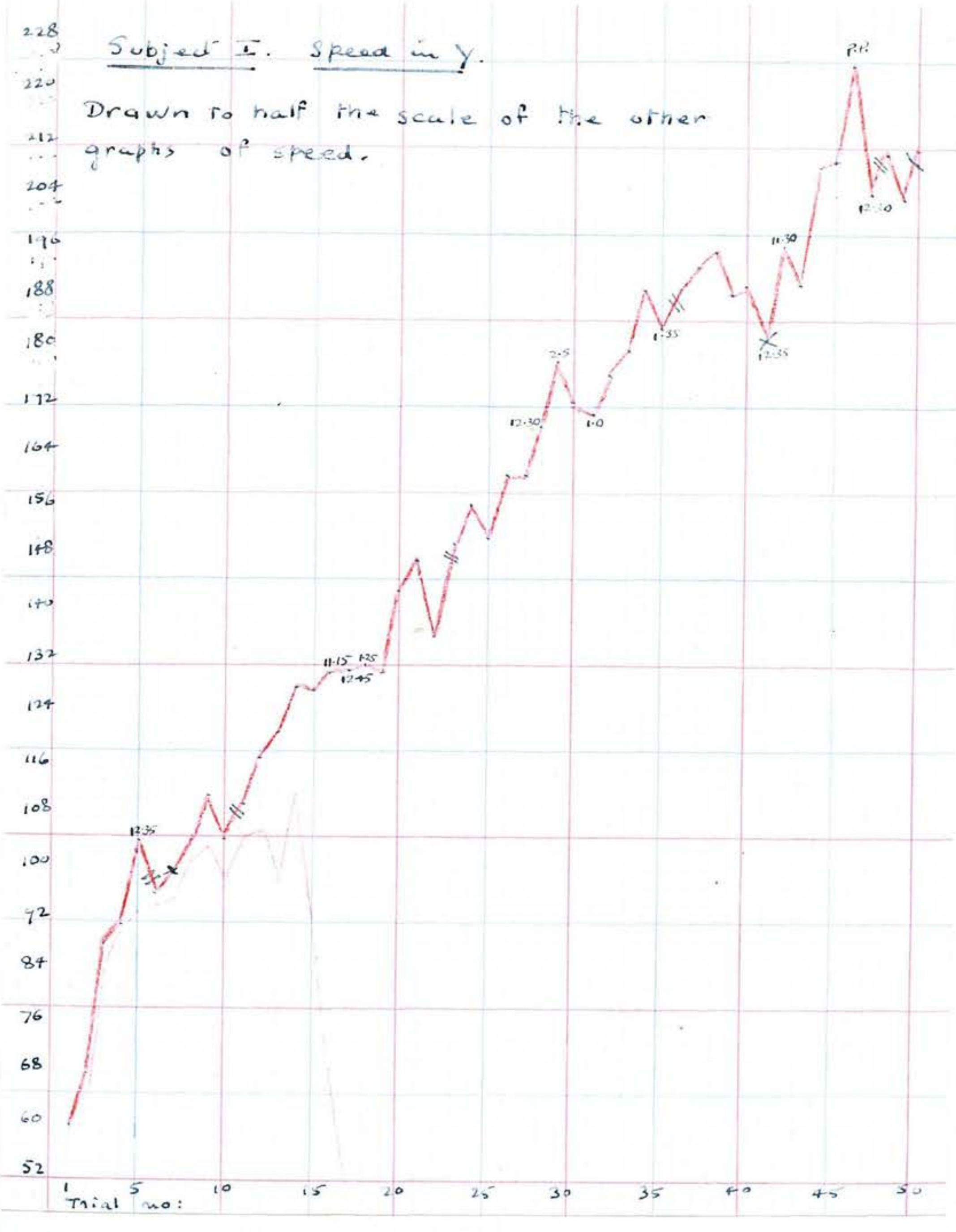
Subject I. Scores when all ws are counted as correct.

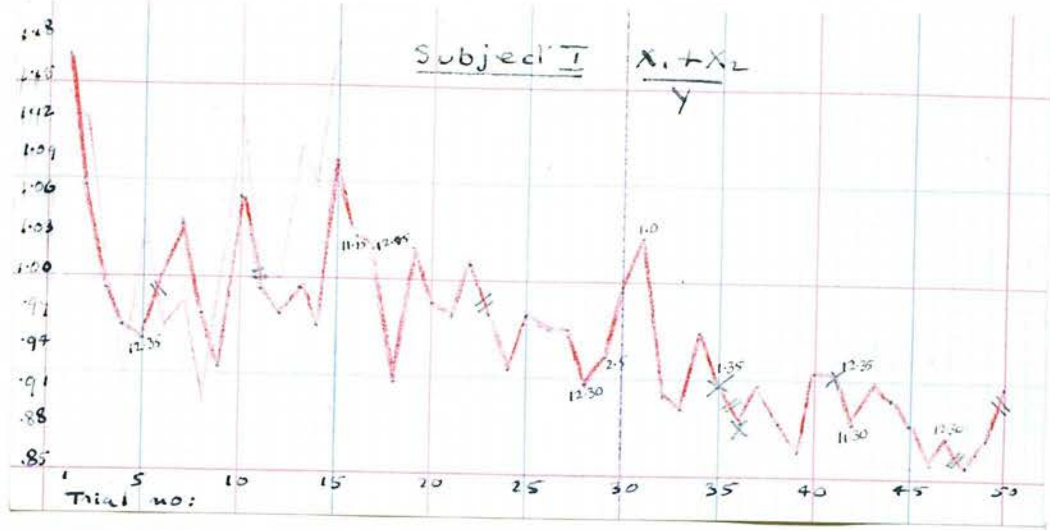
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
37	May 28	10.5 A.M.	87	90	193	.92	.97	1.87	
38	May 29	"	86	87	195	.89	.99	1.87	
39	May 30	"	80	85	189	.87	.94	1.79	
40	May 31	"	86	90	190	.93	.96	1.87	
(41	June 1	12.35 P.M.	86	83	182	.93	1.04	1.99)	S's pencil broke during Y
42	June 2	11.30 A.M.	84	91	196	.89	.92	1.78	Timed at home.
43	June 3	10.5 A.M.	85	89	190	.92	.89	1.85	
44	June 4	"	92	97	208	.91	.95	1.83	
45	June 5	9.5 A.M.	93	92	209	.89	1.01	1.90	Noise during Y.
(46	June 6	10.15 A.M.	95	99	225	.86	.96	1.80)	Done with pressure pencil.
47	June 8	12.30 P.M.	91	88	204	.88	.97	1.86	
(48	June 10	10.5 A.M.	89	91	210	.86	.98	1.83)	
49	June 11	9.10 A.M.	89	89	203	.88	1.00	1.88	
50	June 13	9.5 A.M.	100	95	211	.92	1.05	2.00	

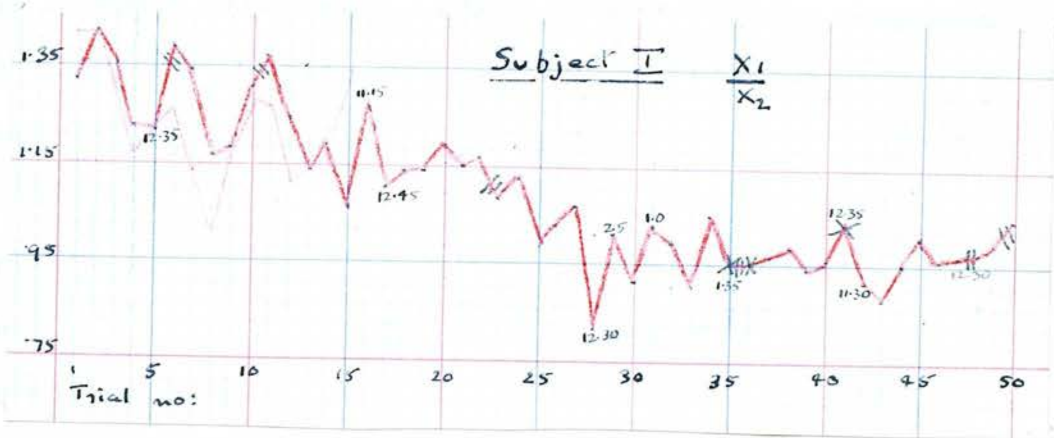
Subject I. Scores for first twenty trials when imperfect ws are counted as errors.

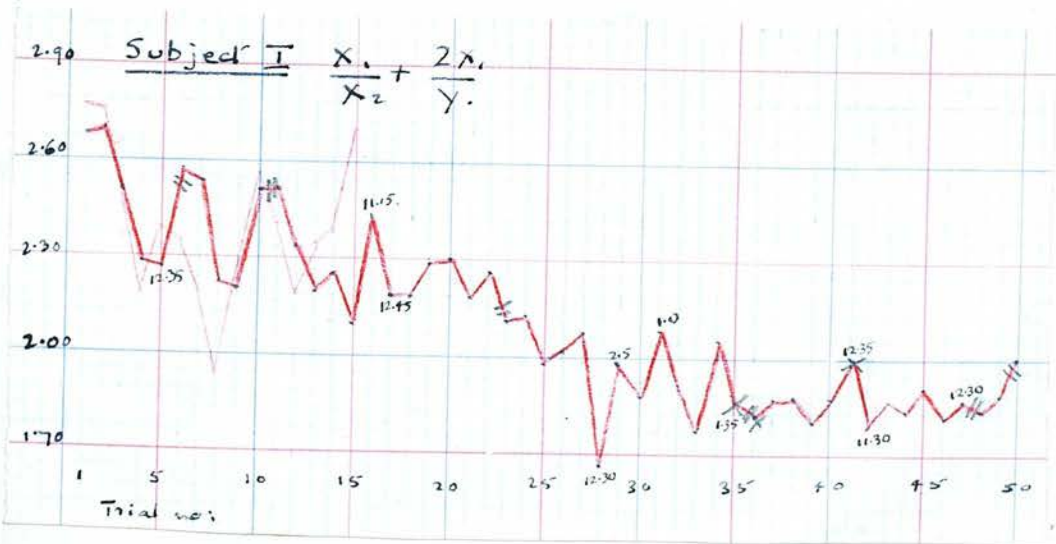
Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
1	40	28 (2)	60	1.13	1.43	2.76
2	43	30	65 (3)	1.12	1.43	2.75
3	49 (1)	37	84 (4)	1.02	1.32	2.49
4	45 (3)	38 (1)	90 (1)	.92	1.18	2.18
5	54 (1)	44 (1)	94 (11)	1.04	1.23	2.38
6	51 (5)	40	95 (1)	.96	1.275	2.345
7	50 (9)	44	96 (3)	.98	1.14	2.18
8	46 (9)	45 (2)	101 (4)	.90	1.02	1.93
9	56	47	103 (8)	1.00	1.19	2.28
10	62 (1)	48	98 (7)	1.12	1.29	2.56
11	59 (4)	46	105 (5)	1.00	1.28	2.40
12	56 (8)	50 (1)	106 (12)	1.00	1.12	2.18
13	58 (6)	50 (6)	98 (23)	1.10	1.16	2.34
14	65 (2)	54 (2)	111 (17)	1.07	1.20	2.37
15	63 (6)	47 (2)	93 (34)	1.18	1.34	2.69
(16	66 (9)	29 (30)	69 (61)	1.38	2.28	4.19)
17	58 (12)	8 (55)	52 (79)	1.27	7.25	9.48
18	51 (15)	44 (12)	59 (73)	1.61	1.16	2.89
19	49 (23)	18 (43)	41 (89)	1.63	2.72	5.11
20	56 (21)	18 (45)	31 (112)	2.39	3.11	6.72


Subject I. Speed in X_1 and X_2
Time of Test 9 to 10.15 A.M.
except where otherwise indicated.
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
Trial no
1
5
10
15
20
25
30
35
40
45
50
12.35
11.15
12.45
1.25
12.30
1.0
1.35
11.30
12.35


Subject I. Speed in Y.
Drawn to half the scale of the other graphs of speed.
228
220
212
204
196
188
180
172
164
156
148
140
132
124
116
108
100
92
84
76
68
60
52
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject I $\frac{X_1 + X_2}{Y}$
Trial no:


Subject I $\frac{X_1}{X_2}$
Trial no:


Subject I $\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Trial no:

Subject J. General Discussion.

Subject J is a man, aged twenty-one, who had done the previous trials at the test, at his natural pace, in Experiment II. He is noteworthy, because his score became practically constant in the later trials, for the scoring $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$. This happened in the case of no other subject.

The graphs show a decrease in the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, up to about the thirteenth trial of the present experiment, after which they are constant. The score $\frac{X_1 + X_2}{Y}$ varies about an approximately constant level. There is a pronounced tendency, for the speed in all the parts of the test to be higher, in those trials which were done at an unusually late hour in the morning. The increase must have been proportionately greater in Y , as the score $\frac{X_1 + X_2}{Y}$ is usually low in these trials. Interruption by noise seems, if anything, to have had a stimulating effect on the performance in Y. The speed in the last trial in X_2 was slightly higher than ever before, and there was a small improvement in the speed of Y as late as the forty-fourth trial. Breaks in the testing tend to be accompanied by a fall in speed.

Subject J practically always put the same number of ws in every line of Y , arranging them in columns; he said that this made it easier, because he/

he copied the line above. It is perhaps a fault in the test, that subjects are able to do this. Even in X_1 and X_2, he had a strong tendency to put the same number of ws in every line. He found it possible, in the latter part of Experiment III, to count the ws in all the parts of the test while writing them, which shows that the reversed ws required less attention in his case, than in that of Subject A.

Subject J gave only one or two short introspections.

Subject J. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov:12	10-11 A.M.	35	22	57	1.00	1.59	2.82	
2	"	"	39	26	68	.96	1.50	2.65	
3	Nov:19	"	39	28	65	1.03	1.39	2.59	
4	"	"	44	34	71	1.10	1.29	2.53	
5	"	"	43	33	75	1.01	1.30	2.45	
6	Nov:26	"	41	32	74	.99	1.28	2.39	
7	"	"	44	36	77	1.04	1.22	2.36	
8	Dec:3	"	44	31	72	1.04	1.42	2.64	
9	"	"	48	38	83	1.04	1.26	2.42	32 secs. between X_2 and Y.
10	"	"	48	36	82	1.02	1.33	2.50	32 secs. berween X_1 and X_2.
Experiment III.									
1	Ap:16	10.55 A.M.	45	33	85	.92	1.36	2.42	
2	Ap:17	10 A.M.	51	37	86	1.02	1.38	2.57	
3	Ap:20	9.20 A.M.	50	39	88	1.01	1.28	2.42	
4	Ap:22	11.5 A.M.	52	41	89	1.04	1.27	2.44	
5	Ap:23	10.5 A.M.	56	44	96	1.04	1.27	2.44	Noise in X_2 and Y.
6	Ap:24	"	57	45	101	1.01	1.27	2.40	
7	Ap:25	11.55 A.M.	56	46	101	1.01	1.22	2.33	
8	Ap:26	10.55 A.M.	55	44	96	1.03	1.25	2.40	
9	Ap:29	11 A.M.	56	43	98	1.01	1.30	2.44	45 seconds between X_1 and X_2. Noise in X_2 and Y.
10	Ap:30	10.55 A.M.	56	46	103	.99	1.22	2.31	
11	May 1	11 A.M.	57	46	96	1.07	1.24	2.43	

Subject J. Scores when all ws are counted as correct.

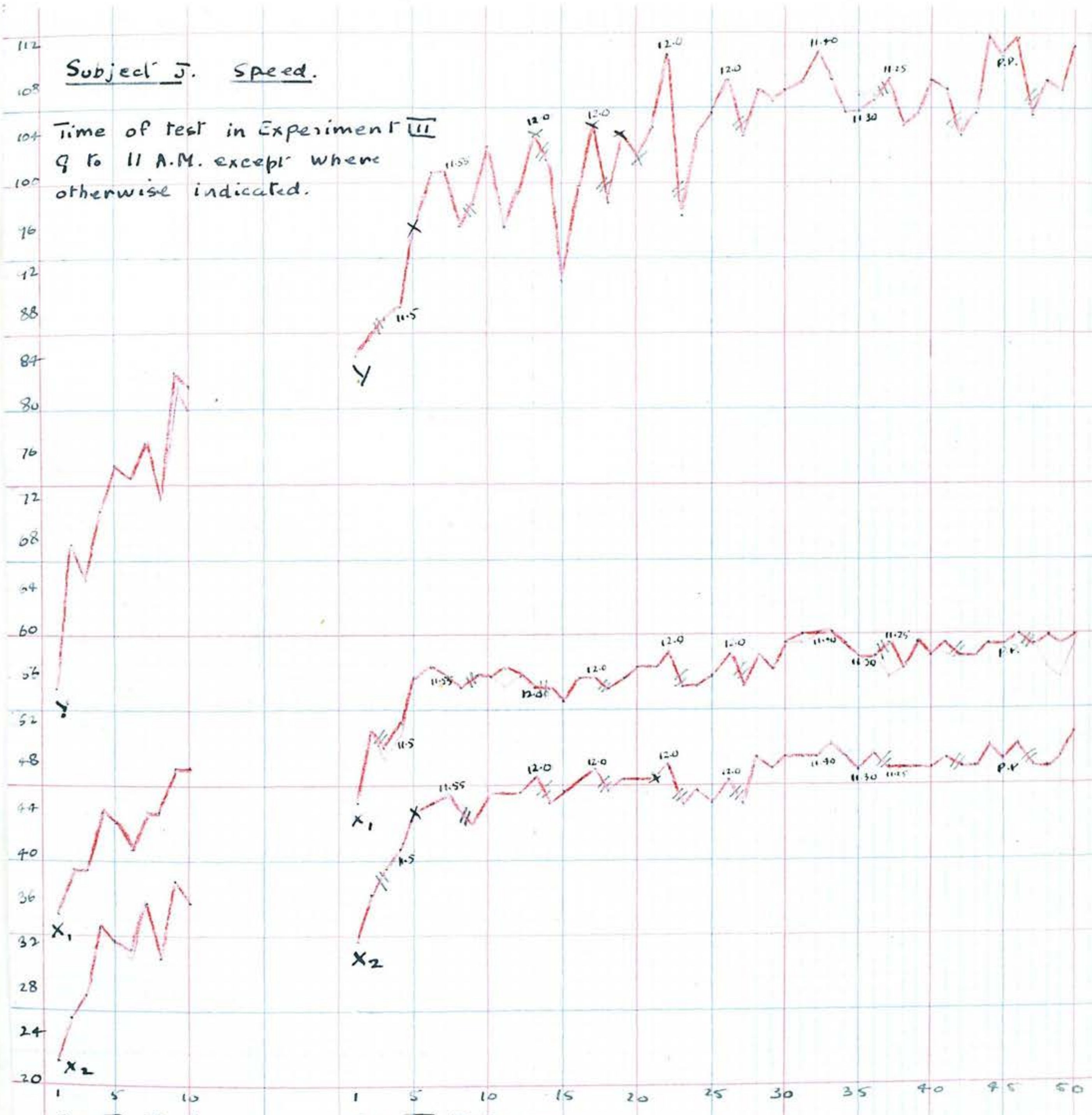
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
12	May 2	10 A.M.	56	46	99	1.03	1.22	2.35	
13	May 3	12 Noon	55	47	104	.98	1.17	2.23	Interruption in Y from someone speaking to E.
14	May 7	10.45 A.M.	55	45	102	.98	1.22	2.30	S. up late the previous night.
15	May 8	11 A.M.	54	46	91	1.10	1.17	2.36	
16	May 9	10 A.M.	56	47	99	1.04	1.19	2.32	"p" error. Noise in Y.
17	May 10	12 Noon	56	48	(1) 105	.99	1.17	2.24	S. said that the previous day's "p" error was due to his mind wandering.
18	May 13	11 A.M.	55	46	98	1.03	1.20	2.32	Noise in Y.
19	May 14	10.50 A.M	56	47	104	.99	1.19	2.27	Noise in Y.
20	May 15	11 A.M.	57	47	102	1.02	1.21	2.33	"p" error. S. said it was due to not paying enough attention.
21	May 16	10.5 A.M.	57	47	(1) 105	.99	1.21	2.30	Noise in X_1.
(22	May 17	12 Noon	58	48	111	.95	1.21	2.26)	Noise in Y.
23	May 21	10.25 A.M	55	45	97	1.03	1.22	2.35	
24	May 22	11 A.M.	55	46	104	.97	1.20	2.26	
25	May 23	9.55 A.M.	56	45	106	1.05	1.24	2.30	Noise in X_1.
26	May 24	12 Noon	58	47	109	.96	1.23	2.29	
27	May 27	10.55 A.M	55	45	104	.96	1.22	2.28	
28	May 28	10.10 A.M	58	49	108	.99	1.18	2.25	
29	May 29	11 A.M.	57	48	107	.98	1.19	2.26	
30	May 30	9.10 A.M.	59	49	108	1.00	1.20	2.29	

Subject J. Scores when all ws are counted as correct.

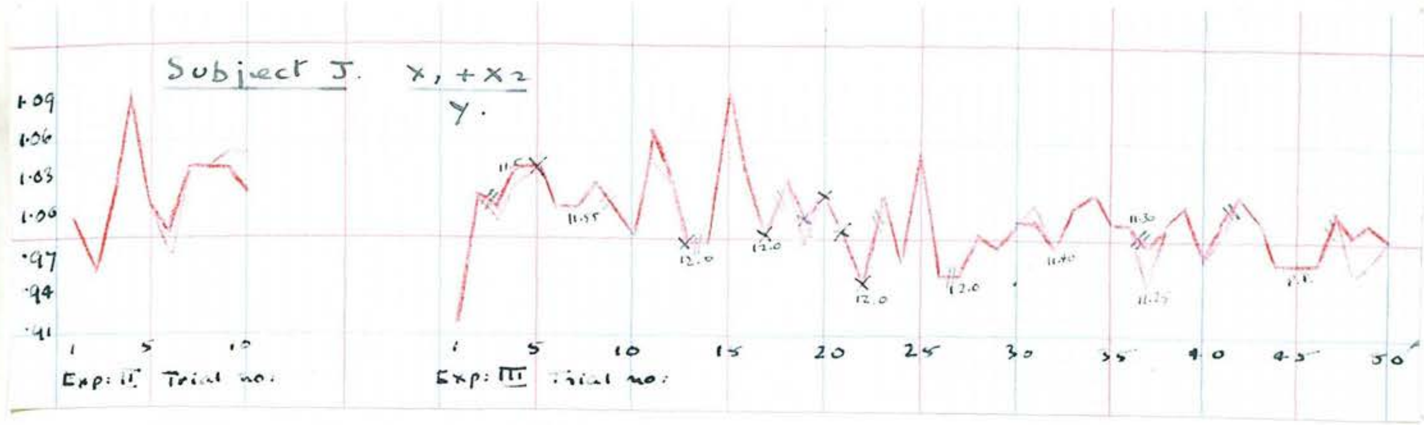
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
31	May 31	9.30 A.M.	60	49	109	1.00	1.22	2.32	
32	June 3	11.40 A.M.	60	49	111	.98	1.22	2.30	After examination.
33	June 4	10.45 A.M.	60	50	109	1.01	1.20	2.30	
34	June 5	9.5 A.M.	59	49	106	1.02	1.20	2.31	Noise in Y.
35	June 6	9.45 A.M.	58	48	106	1.00	1.21	2.30	S. said he counted most of the first line of X_1.
36	June 7	11.30 A.M.	58	49	107	1.00	1.18	2.27	Before examination.
37	June 10	11.25 A.M.	59	48	109	.98	1.23	2.31	
38	June 11	9.10 A.M.	57	48	105	1.00	1.19	2.28	
39	June 12	10.15 A.M.	59	48	106	1.01	1.23	2.34	
40	June 13	9.5 A.M.	58	48	109	.97	1.21	2.27	
41	June 14	9. A.M.	59	49	108	1.00	1.20	2.29	
42	June 17	9.40 A.M.	58	48	104	1.02	1.21	2.33	S. said he had been counting X_1 for some time; it gave him something to think about while writing.
43	June 18	9.20 A.M.	58	48	106	1.00	1.21	2.31	
44	June 19	9.10 A.M.	59	50	113	.96	1.18	2.22	
(45	June 20	9.5 A.M.	59	49	111	.97	1.20	2.26)	Done with pressure pencil.
46	June 21	9.15 A.M.	60	50	113	.97	1.20	2.26	Noise in Y.
47	June 24	"	59	48	106	1.01	1.23	2.34	
48	June 25	"	60	48	109	.99	1.25	2.35	
49	June 26	"	59	49	108	1.00	1.20	2.29	
50	June 27	9.5 A.M.	60	51	112	.99	1.18	2.25	S. said he always counted the first line and the number of lines.

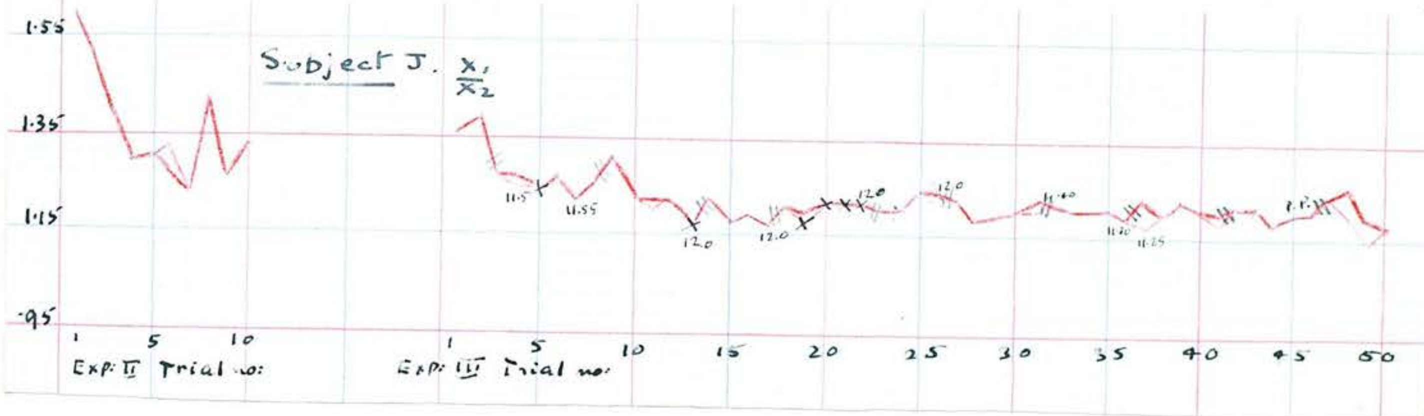
Subject J. Changes in score when imperfect ws are counted as errors.

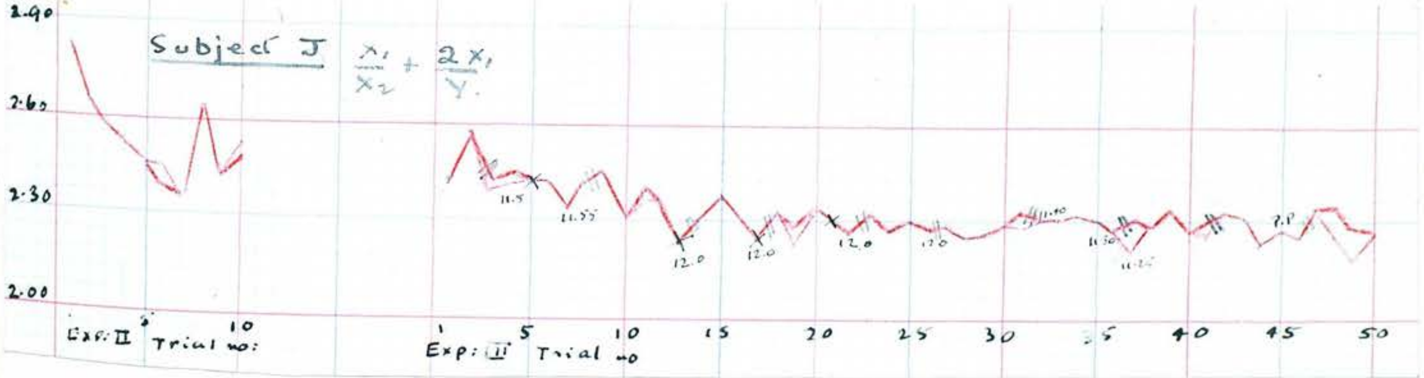
Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
6	41	31 (1)	74	.97	1.32	2.43
9	48	38	82 (1)	1.05	1.26	2.43
10	48	36	80 (2)	1.05	1.33	2.53
Experiment III.						
3	49 (1)	39	88	1.00	1.26	2.37
4	51 (1)	41	89	1.03	1.24	2.39
11	55 (2)	46	96	1.05	1.20	2.35
19	55 (1)	47	104	.98	1.17	2.23
31	59 (1)	49	109	.99	1.20	2.28
37	56 (3)	48	109	.95	1.17	2.20
41	58 (1)	49	108	.99	1.18	2.25
48	57 (3)	48	109	.96	1.19	2.24
49	56 (3)	49	108	.97	1.14	2.18



Subject J. Speed.
Time of test in Experiment III
9 to 11 A.M. except where
otherwise indicated.
Y
X1
X2
Exp: II Trial no:
Exp: III Trial no:


Subject J. $\frac{x_1 + x_2}{y}$
1.09
1.06
1.03
1.00
·97
·94
·91
Exp: II Trial no:
Exp: III Trial no:


Subject J. $\frac{x_1}{x_2}$
1.55
1.35
1.15
·95
Exp: II Trial no:
Exp: III Trial no:


Subject J $\frac{x_1}{x_2} + \frac{2x_1}{y}$
2.90
2.60
2.30
2.00
Exp: II Trial no:
Exp: III Trial no

Subject K. General Discussion.

Subject K is a man, aged twenty-one, who did ten previous trials at the test in Experiment II, as fast as possible.

It can be seen from the graphs, that there is a great deal of irregularity in K's scores. The scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ rise steeply at the beginning of Experiment II, then tend to fall. At the beginning of Experiment III they are higher again, but tend to decrease till the fourteenth trial. From there they fluctuate about an approximately constant level, but show a slight upwards tendency from about the twenty-fifth to the thirty-eighth trial, after which they fall. The score $\frac{X_1 + X_2}{Y}$ rises steeply at the beginning of Experiment II, then falls; it begins at a higher level in Experiment III, and fluctuates about this level for the rest of the time.

K gave only a few introspections.

Subject K. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov:9	3-4 P.M.	26	20	47	.98	1.30	2.41	
2	"	"	38	24	60	1.03	1.58	2.84	
3	Nov:16	"	40	23	45	1.40	1.74	3.52	S. disturbed in X_2 by opening of door.
4	"	"	47	26	75	.97	1.81	3.06	
5	"	"	50	32	78	1.05	1.56	2.84	
6	Nov:23	"	50	28	73	1.07	1.79	3.16	"Beginning to find ws easier now. The reversed ws give me a pain in my wrist."
7	"	"	56	31	82	1.06	1.81	3.18	
8	Nov:30	"	46	27	70	1.04	1.70	3.01	
9	"		47	28	82	.91	1.68	2.83	
10	"		54	34	100	.88	1.59	2.67	
Experiment III.									
1	Ap:17	10 A.M.	47	26	73	1.00	1.81	3.10	
2	Ap:18	"	47	29	78	.97	1.62	2.83	Timed at home.
3	Ap:19	"	48	24	70	1.03	2.00	3.37	Timed at home. S. said that the reversed ws felt awkward and his hand tired easily.

Subject K. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
4	Ap:20	10 A.M.	46	24	65	1.08	1.92	3.34	Timed at home.
5	Ap:21	"	48	28	78	.97	1.71	2.94	Timed at home. On smaller paper. "The reversed ws .. still .. troublesome ... "
6	Ap:23	10.5 A.M.	51	34	78	1.09	1.50	2.81	Interruption in Y by someone speaking to E.
7	Ap:24	"	55	33	74	1.19	1.67	3.16	
8	Ap:25	"	51	34	76	1.12	1.50	2.84	
9	Ap:26	"	51	36	80	1.09	1.42	2.695	S. heard I told that the scoring was to be more lenient.
10	Ap:29	10.5 A.M.	53	36	83	1.07	1.47	2.75	
11	May 1	"	53	35	80	1.10	1.51	2.835	
12	May 2	"	48	33	79 (1)	1.03	1.45	2.67	"p" error.
13	May 3	10 A.M.	52	36	86	1.02	1.44	2.65	
14	May 4	10.5 A.M.	45	37	80	1.025	1.22	2.345	Timed at home.
15	May 5	"	50	37	82	1.06	1.35	2.57	" " "
16	May 6	"	48	35	83	1.00	1.37	2.53	" " "
17	May 7	11 A.M.	51	38	82	1.09	1.34	2.58	
18	May 8	10.5 A.M.	52	34	78 (1)	1.10	1.53	2.85	"p" error.
19	May 10	"	52	38	84	1.07	1.37	2.61	S. said he could not account for the "p" error.
20	May 11	12.30 P.M.	48	37	74	1.15	1.30	2.60	Timed at home.
21	May 12	10.5 A.M.	49	37	75	1.15	1.32	2.63	" " "
22	May 13	"	53	40	78	1.19	1.325	2.685	

Subject K. Scores when all ws are counted as correct.

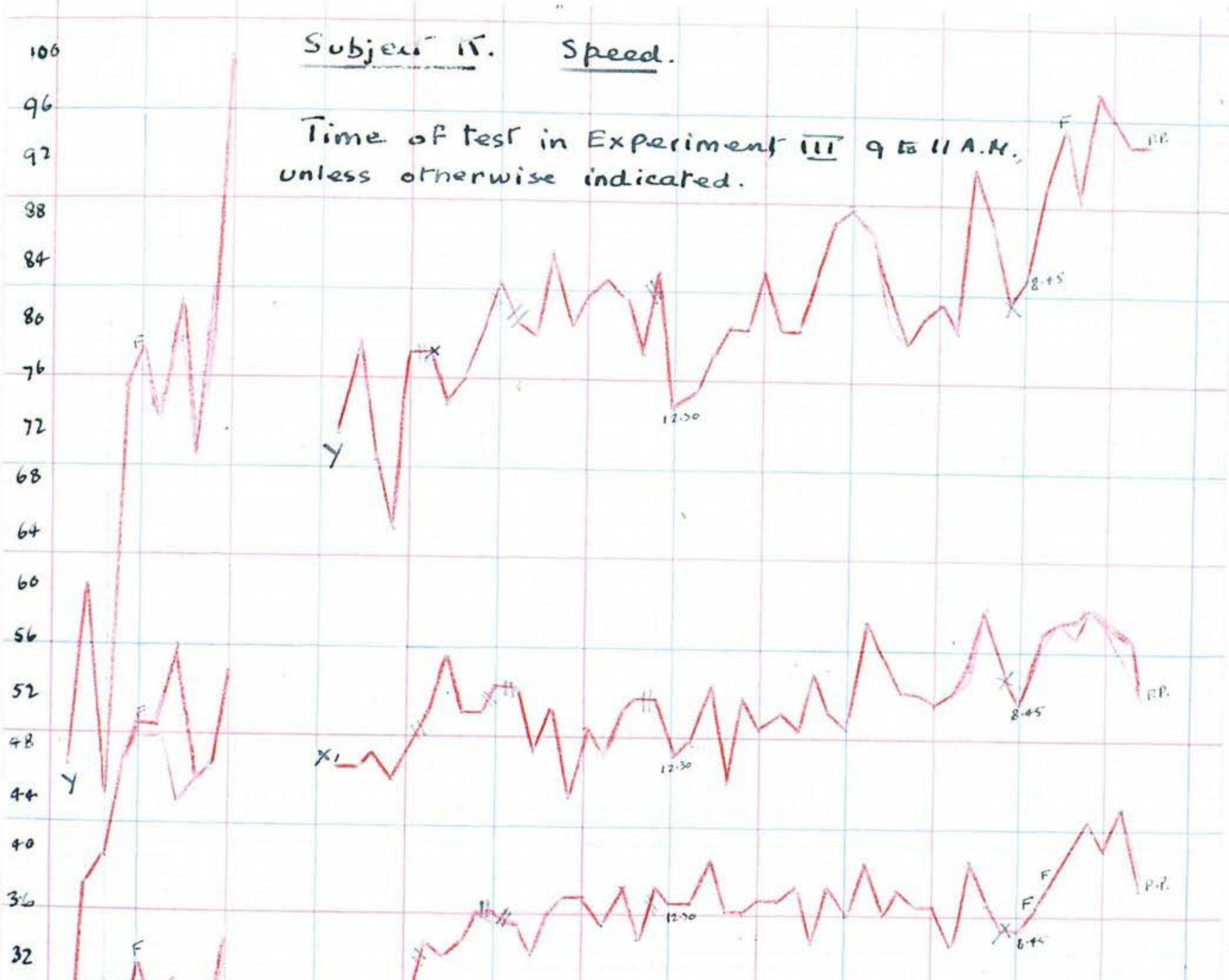
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
23	May 14	10.5 A.M.	46	36	80	1.025	1.28	2.43	
24	May 15	"	52	36	80	1.10	1.44	2.74	
25	May 16	10.10 A.M.	50	37	84	1.04	1.35	2.54	
26	May 17	10.5 A.M.	51	37	80	1.10	1.38	2.655	
27	May 18	"	50	38	80	1.10	1.32	2.37	
28	May 19	"	54	34	84	1.05	1.59	2.88	
29	May 20	9.45 A.M.	51	38	88	1.01	1.34	2.50	
30	May 21	10.5 A.M.	50	36	89	.97	1.39	2.51	
31	May 22	"	58	40	87	1.13	1.45	2.78	
32	May 23	"	55	36	82	1.11	1.53	2.87	
33	May 24	"	53	38	79	1.15	1.39	2.73	
34	May 25	12 Noon	53	37	81	1.11	1.43	2.74	Timed at home.
35	May 26	10.5 A.M.	52	37	82	1.09	1.41	2.68	" " "
36	May 27	"	53	34	80	1.09	1.56	2.885	S. did several practice ws in the air before X_2
37	May 28	"	55	40	92	1.03	1.375	2.575	
38	May 29	10.10 A.M.	59	37	88	1.09	1.59	2.93	
39	May 30	9.10 A.M.	54	35	82	1.09	1.54	2.86	
40	May 31	10.5 A.M.	52	35	84	1.04	1.49	2.73	S's hands appeared cold.
41	June 1	8.45 A.M.	57	37	90	1.04	1.54	2.81	Timed at home. "The reversed w seemed to come much more easily to-day than it has done for some .. time ... they seemed to flow automatically from the pencil."

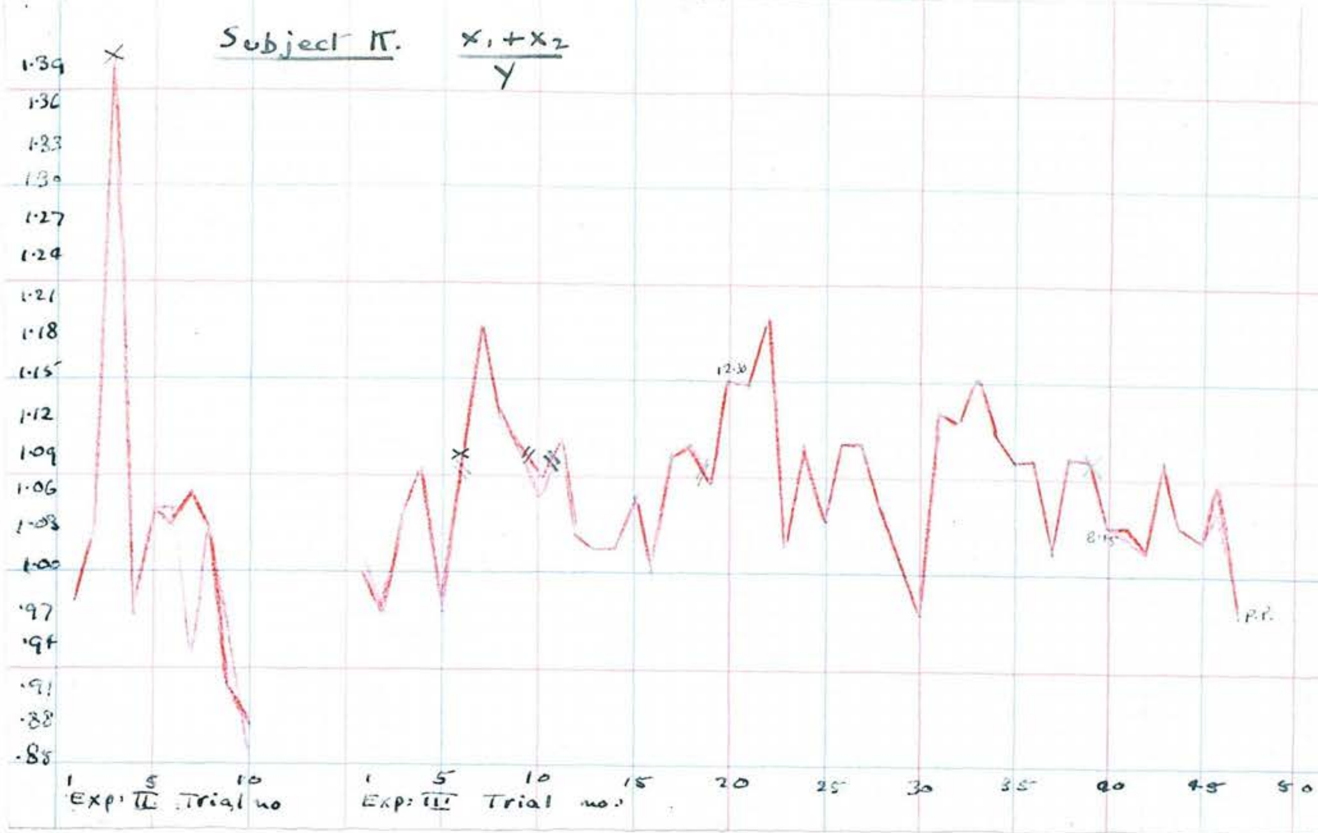
Subject K. Scores when all ws are counted as correct.

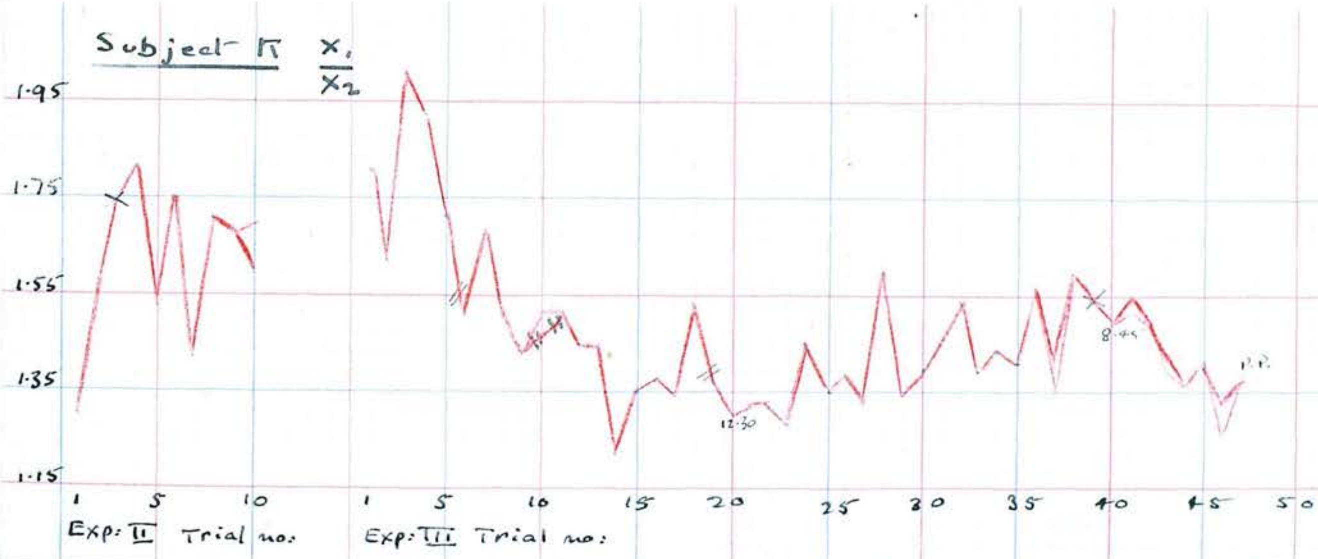
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
42	June 2	11 A.M.	58	39	95	1.02	1.49	2.71	Timed at home. S. said reversed ws were again easy, and alternating ones less difficult than usual.
43	June 3	11.45 A.M.	58	41	90	1.10	1.41	2.70	After examination.
44	June 4	10.5 A.M.	59	43	98	1.04	1.37	2.57	
45	June 5	"	58	41	96	1.03	1.41	2.62	
46	June 6	"	57	44	94	1.07	1.30	2.51	S. did several practice reversed ws on the table before starting X_2.
(47	June 7	10.10 A.M.	53	39	94	.98	1.36	2.49)	Done with pressure pencil.

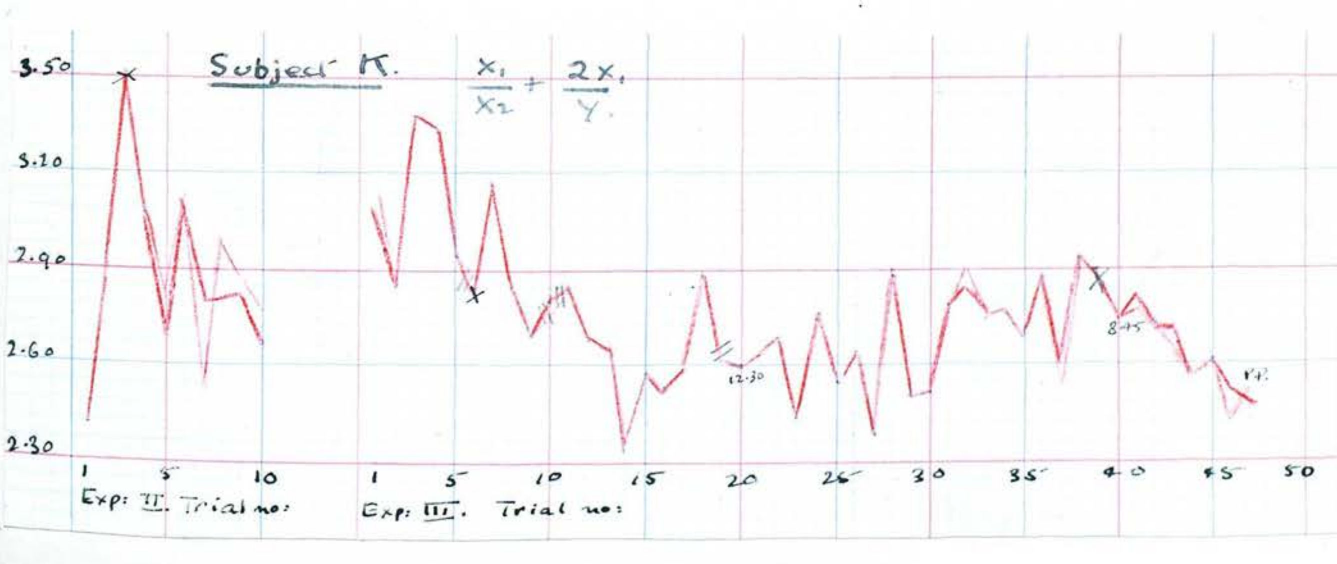
Subject K. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
5	49 (1)	32	77 (1)	1.05	1.56	2.84
6	49 (1)	28	73	1.05	1.79	3.13
7	44 (12)	31	80 (2)	.94	1.81	2.91
9	47	28	79 (3)	.95	1.68	2.87
10	54	32 (2)	100	.86	1.69	2.77
Experiment III.						
1	47	26	72 (1)	.99	1.81	3.12
10	53	35 (1)	83	1.06	1.51	2.79
32	55	36	81 (1)	1.12	1.53	2.89
37	54 (1)	40	92	1.02	1.35	2.52
41	56 (1)	37	90	1.03	1.51	2.75
43	57 (1)	41	90	1.09	1.39	2.66
46	55 (2)	44	94	1.05	1.25	2.42
(47	53	38 (1)	94	.97	1.39	2.52)


Subject K. Speed.
Time of test in Experiment III 9 to 11 A.M., unless otherwise indicated.
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
Y
X₁
X₂
F
S
12.30
8.45
F.P.
1
5
10
15
20
25
30
35
40
45
50
Exp II Trial no:
Exp: III Trial no:


Subject K. $\frac{x_1+x_2}{Y}$
1·39
1·36
1·33
1·30
1·27
1·24
1·21
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
·91
·88
·85
12·30
8·45
P.P.
1 5 10
Exp: II Trial no
1 5 10 15 20 25 30 35 40 45 50
Exp: III Trial no:


Subject K $\frac{x_1}{x_2}$
1·95
1·75
1·55
1·35
1·15
8·45
P.P.
12·30
1 5 10
Exp: II Trial no:
1 5 10 15 20 25 30 35 40 45 50
Exp: III Trial no:


Subject K. $\frac{x_1}{x_2}+\frac{2x_1}{Y}$
3·50
3·20
2·90
2·60
2·30
8·45
12·30
P.P.
1 5 10
Exp: II. Trial no:
1 5 10 15 20 25 30 35 40 45 50
Exp: III. Trial no:

Subject L. General Discussion.

Subject L is a woman, aged twenty-eight. She did ten previous trials at the test in Experiment II, at her maximum speed.

It can be seen from the graphs, that the scores $\frac{X1}{X2}$ and $\frac{X1}{X2} + \frac{2X1}{Y}$ drop steeply at the beginning of Experiment II and tend to decrease gradually up to about the twenty-ninth trial of Experiment III, after which they tend to rise a little, then remain level. The pronounced drop, both in speed and perseveration score, at the thirty-first trial, and the lesser one at the twentieth, are due to cold hands.

Subject L gave only a few introspections.

Subject L. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov.14	3-4 P.M.	31	13	38	1.16	2.38	4.01	"Had difficulty with reversed ws when written by themselves as thought of their actual shape, but not so much when made the two together."
2	Nov.14	3-4 P.M.	36	20	54	1.04	1.80	3.13	
3	Nov.21	"	37	22	60	.98	1.68	2.91	
4	"	"	42	28	77	.91	1.50	2.59	
5	"	"	45	26	73	.97	1.73	2.96	
6	Nov.28	"	40	27	74	.91	1.48	2.56	
7	"	"	43	32	82	.91	1.34	2.39	
8	Dec.5	"	44	32	73	1.04	1.38	2.59	
9	"	"	46	34	80	1.00	1.35	2.50	
10	"	"	49	35	84	1.00	1.40	2.57	
Experiment III.									
1	Ap.16	10.55 A.M.	37	27	65	.98	1.37	2.51	
2	Ap.17	"	42	27	70	.99	1.56	2.76	
3	Ap.18	11 A.M.	41	27	72	.94	1.52	2.66	
4	Ap.22	"	43	29	78	.92	1.48	2.58	
5	Ap.23	"	44	32	81	.94	1.375	2.465	
6	Ap.24	"	43	31	77	.96	1.39	2.51	
7	Ap.25	"	44	29	75	.97	1.52	2.69	

Subject L. Scores when all ws are counted as correct.

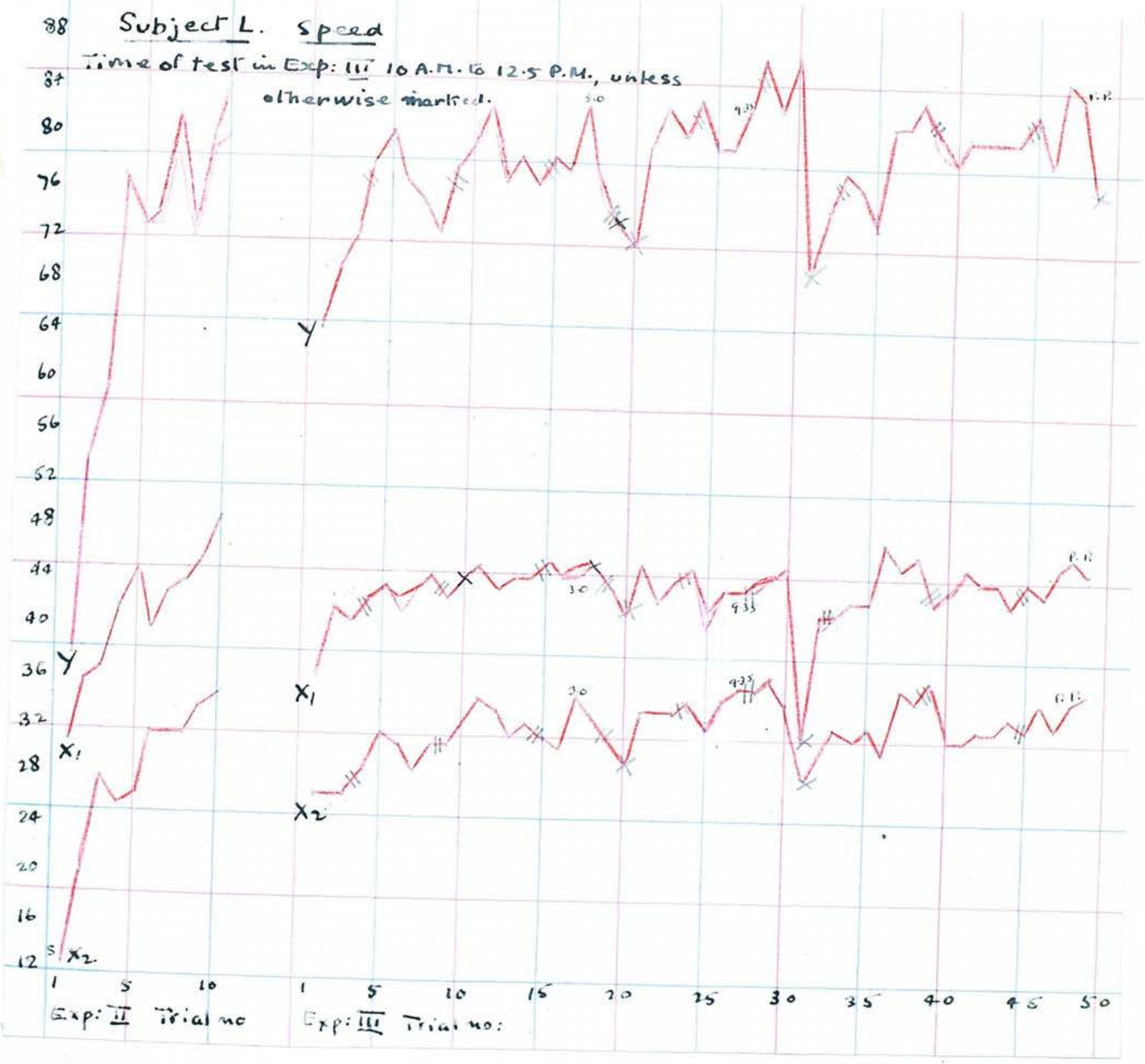
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
8	Ap:26	11 A.M.	43	31	73	1.04	1.45	2.68	
9	Ap:29	"	43	31	78	.95	1.39	2.49	45 secs: between X_1 and X_2 Noise in X_2 and Y.
10	Ap:30	10.45 A.M.	45	33	80	.975	1.36	2.485	35 secs: between X1 and X_2. Banging on door in X1.
11	May 1	11 A.M.	46	35	83	.98	1.31	2.42	
12	May 2	"	44	34	77	1.01	1.29	2.43	
13	May 3	"	45	32	79	.97	1.41	2.55	
14	May 4	"	45	33	77	1.01	1.36	2.53	
15	May 7	"	46	32	79	.99	1.44	2.60	
16	May 8	"	45	31	78	.97	1.45	2.60	
17	May 9	3 P.M.	46	35	83	.98	1.31	2.42	
(18	May 10	12.5 P.M.	46	34	77 (1)	1.05	1.35	2.56)	One "p" error. Interruption in Y from someone whispering to E.
19	May 13	11 A.M.	44	32	74	1.03	1.375	2.565	Noise in Y .
(20	May 14	"	42	30	72	1.00	1.40	2.57)	S's hands cold.
21	May 15	11.55 A.M.	46	34	80	1.00	1.35	2.50	Noise in X_2 and Y .
22	May 16	10.55 A.M.	43	34	83	.93	1.26	2.30	
23	May 17	12 Noon	45	34	81	.98	1.32	2.43	
24	May 22	11 A.M.	46	35	84	.96	1.31	2.41	
25	May 23	12 Noon	41	33	80	.925	1.24	2.265	
26	May 24	"	44	35	80	.99	1.26	2.36	
(27	May 25	9.35 A.M.	44	36	83	.96	1.22	2.28)	Discarded because early hour may have affected score.

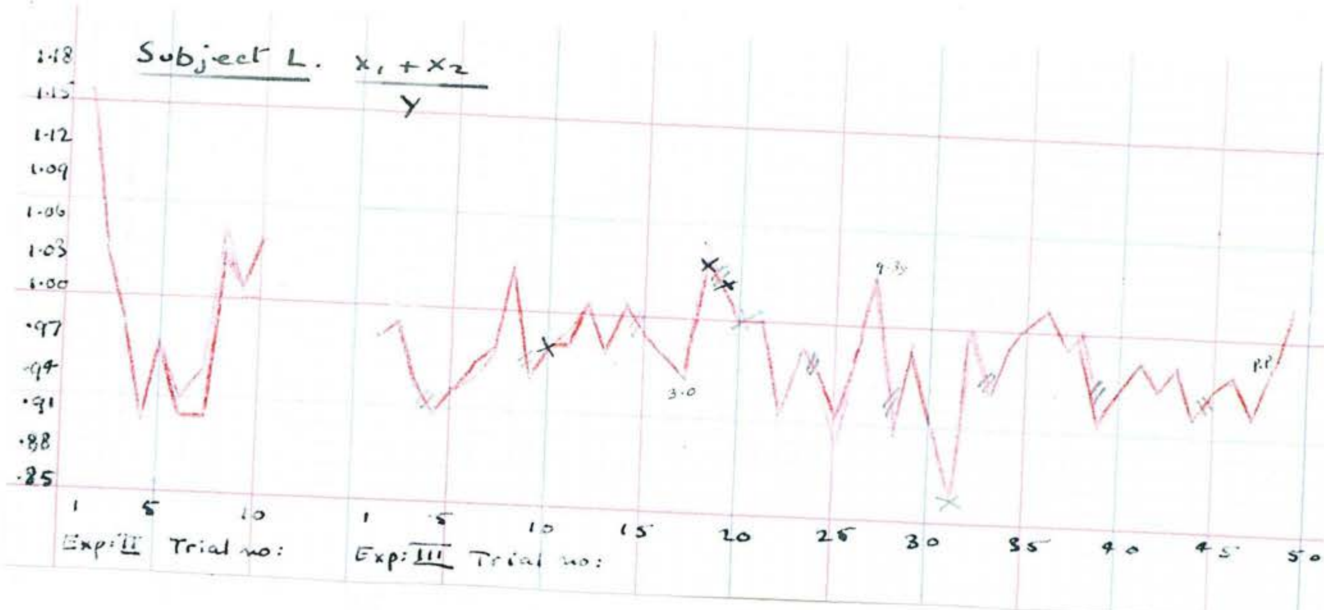
Subject L. Scores when all ws are counted as correct.

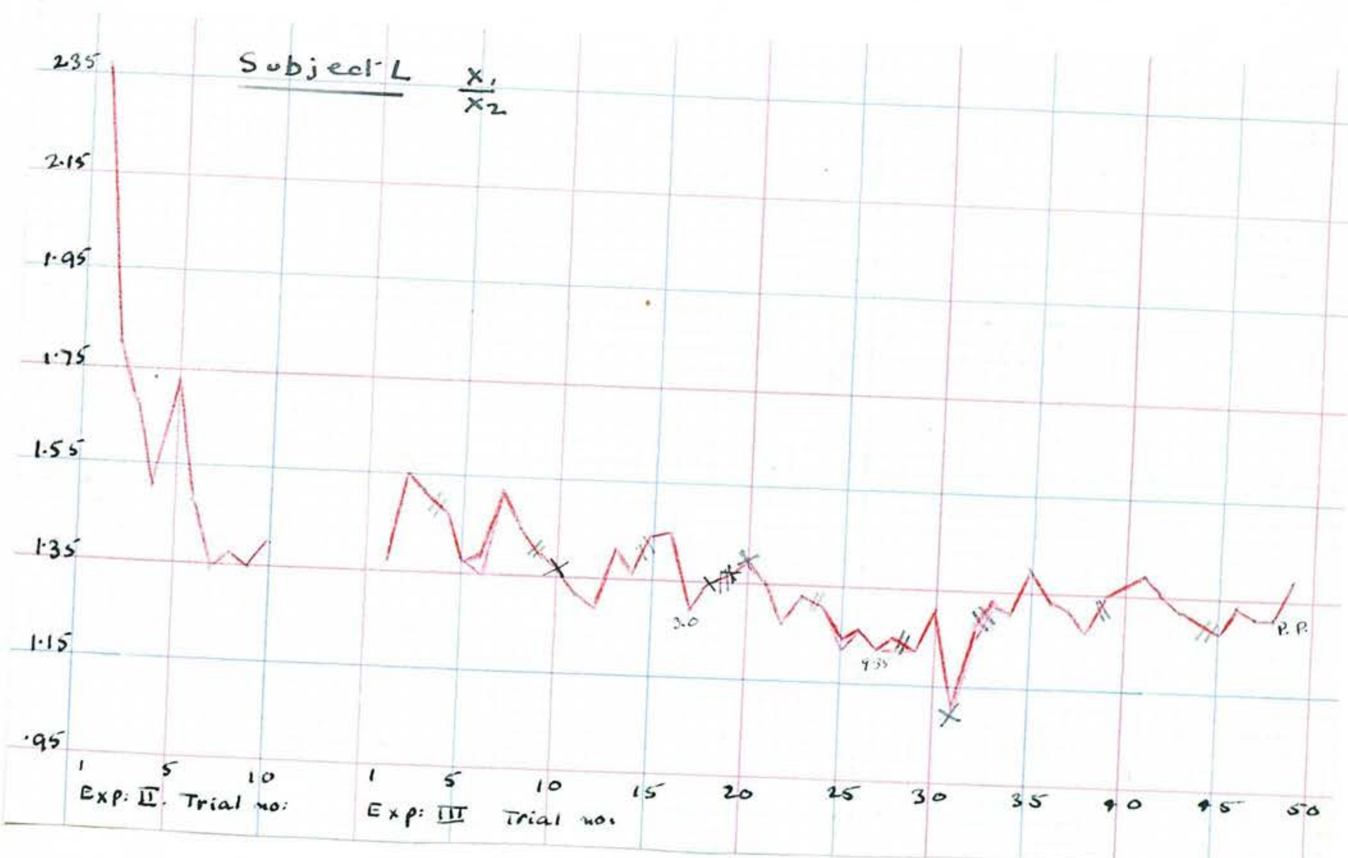
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
(28	May 27	10.55 A.M.	45	36	87	.93	1.25	2.28)	Discarded because the interval may have affected the score $\frac{X_1 + X_2}{Y}$ which is very low when imperfect ws are counted as errors.
29	May 28	10.50 A.M.	45	37	83	.99	1.22	2.30	
30	May 29	11 A.M.	46	35	87	.93	1.31	2.37	
(31	May 30	11.55 A.M.	32	29	70	.87	1.10	2.01)	S's hands very cold.
32	May 31	"	42	33	75	1.00	1.27	2.39	
33	June 3	11 A.M.	42	32	78	.95	1.31	2.39	
34	June 4	"	43	33	77	.99	1.30	2.42	Noise in X_2.
35	June 5	11.15 A.M.	43	31	74	1.00	1.39	2.55	
36	June 6	11 A.M.	48	36	82	1.02	1.33	2.50	
37	June 7	11.45 A.M.	46	35	82	.99	1.31	2.33	Before examination.
38	June 8	10.5 A.M.	47	37	84	1.00	1.27	2.39	
39	June 10	11 A.M.	43	32	81	.93	1.34	2.40	
40	June 11	"	44	32	79	.96	1.375	2.485	
41	June 12	"	46	33	81	.98	1.39	2.53	
42	June 13	10.55 A.M.	45	33	81	.96	1.36	2.47	
43	June 14	"	45	34	81	.98	1.32	2.43	
44	June 15	"	43	33	81	.94	1.30	2.36	
45	June 17	"	45	35	83	.96	1.29	2.37	
46	June 18	11	44	33	79	.97	1.33	2.44	
47	June 19	"	46	35	86	.94	1.31	2.38	
(48	June 20	10.15 A.M.	47	36	85	.98	1.31	2.42)	Done with pressure pencil.

Subject L. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
6	40	27	73 (1)	.92	1.48	2.58
7	43	32	79 (3)	.95	1.34	2.43
8	44	32	72 (1)	1.06	1.38	2.60
9	46	34	79 (1)	1.01	1.35	2.51
10	49	35	80 (4)	1.05	1.40	2.625
Experiment III.						
6	42 (1)	31	77	.95	1.35	2.44
11	46	35	82 (1)	.99	1.31	2.43
17	45 (1)	35	83	.96	1.29	2.37
(18	46	34	75 (2)	1.07	1.35	2.58)
25	40 (1)	33	80	.91	1.21	2.21
(28	44 (1)	36	87	.92	1.22	2.23)
32	41 (1)	33	75	.99	1.24	2.33
39	43	32	80 (1)	.94	1.34	2.415


Subject L. Speed
Time of test in Exp: III 10 A.M. to 12.5 P.M., unless otherwise marked.
Y
X1
X2
Exp: II Trial no
Exp: III Trial no:


Subject L. $\frac{x_1 + x_2}{y}$
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
·91
·88
·85
3·0
P.P.
Exp: II Trial no:
Exp: III Trial no:
1 5 10
1 5 10 15 20 25 30 35 40 45 50


Subject L $\frac{x_1}{x_2}$
2·35
2·15
1·95
1·75
1·55
1·35
1·15
·95
3·0
P. P.
Exp: II. Trial no:
Exp: III Trial no.
1 5 10
1 5 10 15 20 25 30 35 40 45 50

Subject L
$\frac{x_1}{x_2} \div \frac{2x_1}{y}$
4·10
3·80
3·50
3·20
2·90
2·60
2·30
2·00
1 5 10
Exp: II Trial no.
1 5 10 15 20 25 30 35 40 45 50
Exp: III Trial no.
3.0
P.P.

Subject M. General Discussion.

Subject M is a man, aged twenty-one, who had had no previous practice at the test. His speed is lower than that of any subject except R.

The graphs show that the perseveration score, by all three methods of scoring, fluctuates about an approximately constant level. The fluctuations of the score $\frac{X_1 + X_2}{Y}$ are unusually great. It must of course be remembered, that the "ratio method" of scoring makes the fluctuations greater, the lower the speed in the test; at the same time, this score fluctuates much more in the case of M, than in that of C, who wrote almost as slowly. The drop in the speed of Y, at trial 15, was caused by the fact that M made an "interference" error, but there is nothing to account for the drop at trial 28. Rapid writing, preceding the test, appears to have caused a rise in the speed of X_1 at trial 40, and in that of Y at trial 44.

M gave a great many introspections, the more interesting of which will be quoted. These deal largely with the rhythm in which he worked.

Subject M. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
1	Ap:12	9.45 A.M.	25	19	41	1.07	1.32	2.54	
2	Ap:15	"	30	23	46	1.15	1.30	2.60	
3	Ap:16	"	32	24	53	1.06	1.33	2.54	
4	Ap:17	8.45 A.M.	33	24	54 (1)	1.06	1.375	2.595	"p" error.
5	Ap:18	9.45 A.M.	36	26	53	1.17	1.38	2.74	
6	Ap:19	9.50 A.M.	34	22	50	1.12	1.55	2.91	
7	Ap:22	8.50 A.M.	35	27	56	1.11	1.30	2.55	
8	Ap:23	9.45 A.M.	35	25	67	.90	1.40	2.44	S. nearly made a "p" error.
9	Ap:24	8.50 A.M.	38	30	66	1.03	1.27	2.42	
10	Ap:25	10 A.M.	38	32	59	1.19	1.19	2.48	
11	Ap:26	8.50 A.M.	40	27	66	1.02	1.48	2.69	Noise in Y.
12	Ap:29	8.55 A.M.	40	28	69	.99	1.43	2.59	
13	Ap:30	9.45 A.M.	42	31	68	1.07	1.35	2.59	
14	May 1	8.45 A.M.	42	29	67	1.06	1.45	2.70	S. up late the previous night,
15	May 2	9.45 A.M.	41	28	54 (4)	1.28	1.46	2.98	45 seconds between X2 and Y. An "interference" and a "p" error.
16	May 3	11 A.M.	41	31	65	1.11	1.32	2.58	
17	May 7	"	39	30	67	1.03	1.30	2.46	
18	May 8	11.50 A.M.	43	31	69	1.07	1.39	2.64	
19	May 9	11 A.M.	44	33	64 (1)	1.20	1.33	2.705	"p" error.
20	May 10	8.50 A.M.	41	31	71	1.01	1.32	2.47	
21	May 13	"	42	30	71	1.01	1.40	2.58	
22	May 14	9.50 A.M.	43	33	70	1.09	1.30	2.53	
23	May 15	8.55 A.M.	42	35	74	1.04	1.20	2.34	Noise in Y.
24	May 16	9.45 A.M.	41	35	72	1.06	1.17	2.31	

Subject M. Scores when all ws are counted as correct.

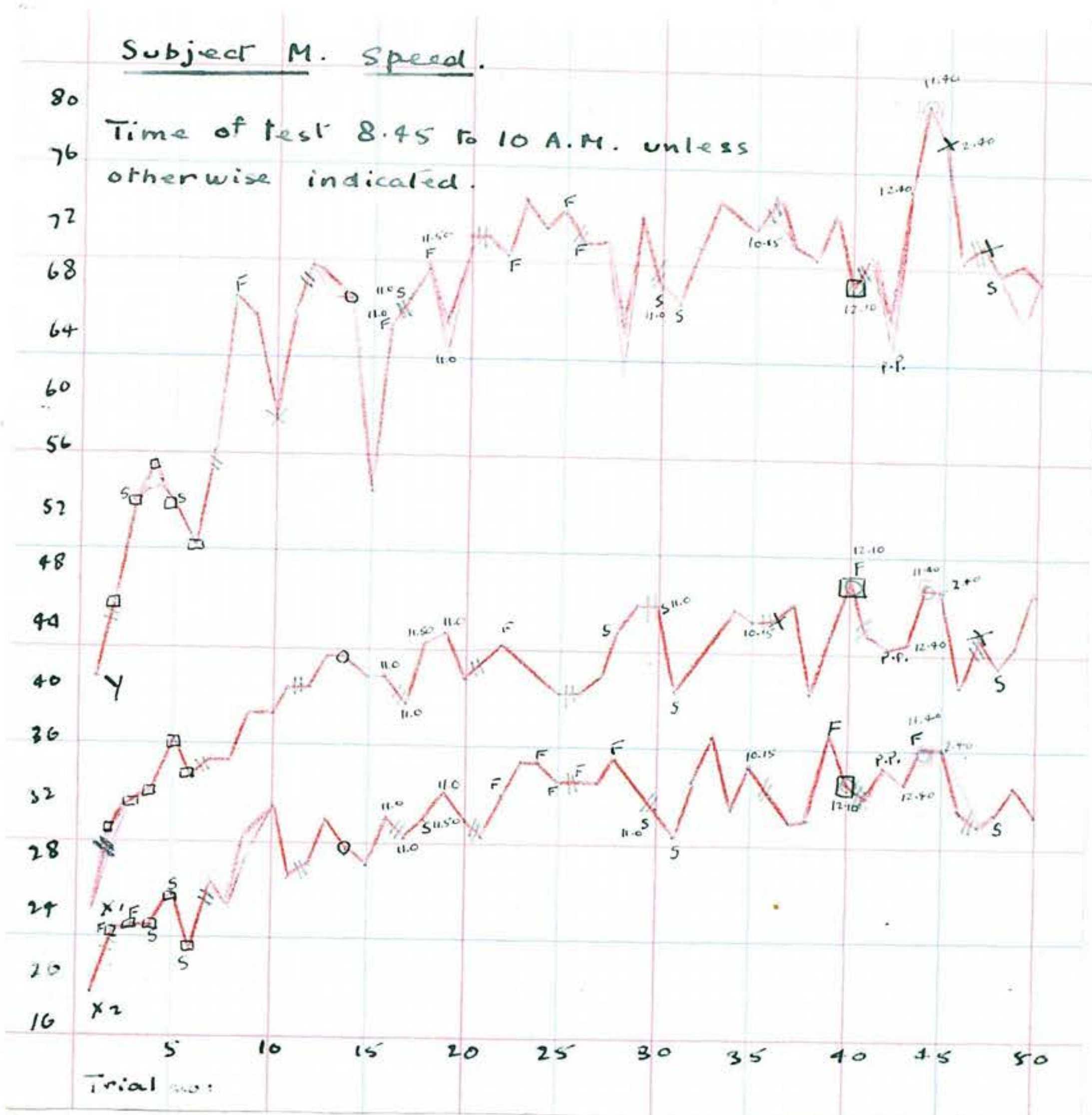
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
25	May 17	8.55 A.M.	40	34	73	1.01	1.18	2.28	Slight noise in X_2 and Y.
26	May 21	9.45 A.M.	40	33	71	1.03	1.21	2.34	
27	May 22	8.50 A.M.	41	33	71	1.04	1.24	2.39	
28	May 23	9.50 A.M.	44	36	63	1.24	1.29	2.69	
29	May 24	8.50 A.M.	46	33	73	1.08	1.39	2.65	
30	May 27	11 A.M.	46	32	68	1.15	1.44	2.79	
31	May 28	9.45 A.M.	40	30	67	1.04	1.33	2.52	
32	May 29	8.50 A.M.	42	34	71	1.07	1.24	2.42	
33	May 30	9.50 A.M.	44	37	74	1.09	1.19	2.38	
34	May 31	8.50 A.M.	46	32	73	1.07	1.44	2.70	
35	June 3	10.15 A.M.	45	35	72	1.11	1.29	2.54	
36	June 4	9.45 A.M.	45	33	73(1)	1.07	1.36	2.59	"p" error. Slight noise in Y.
37	June 5	9.55 A.M.	46	31	71	1.08	1.48	2.78	
38	June 6	9.45 A.M.	40	31	70	1.01	1.29	2.43	
39	June 7	"	44	37	73 (1)	1.11	1.19	2.40	"p" error. S. stopped after it
40	June 8	12.10 P.M.	48	34	68	1.21	1.41	2.82	After examination. S. had been writing fast, and was worried. He had been up late working the previous night.
41	June 10	9.55 A.M.	44	33	70	1.10	1.33	2.59	
(42	June 11	9.50 A.M.	43	35	64 (1)	1.20	1.23	2.55)	Done with pressure pencil. "p" error.

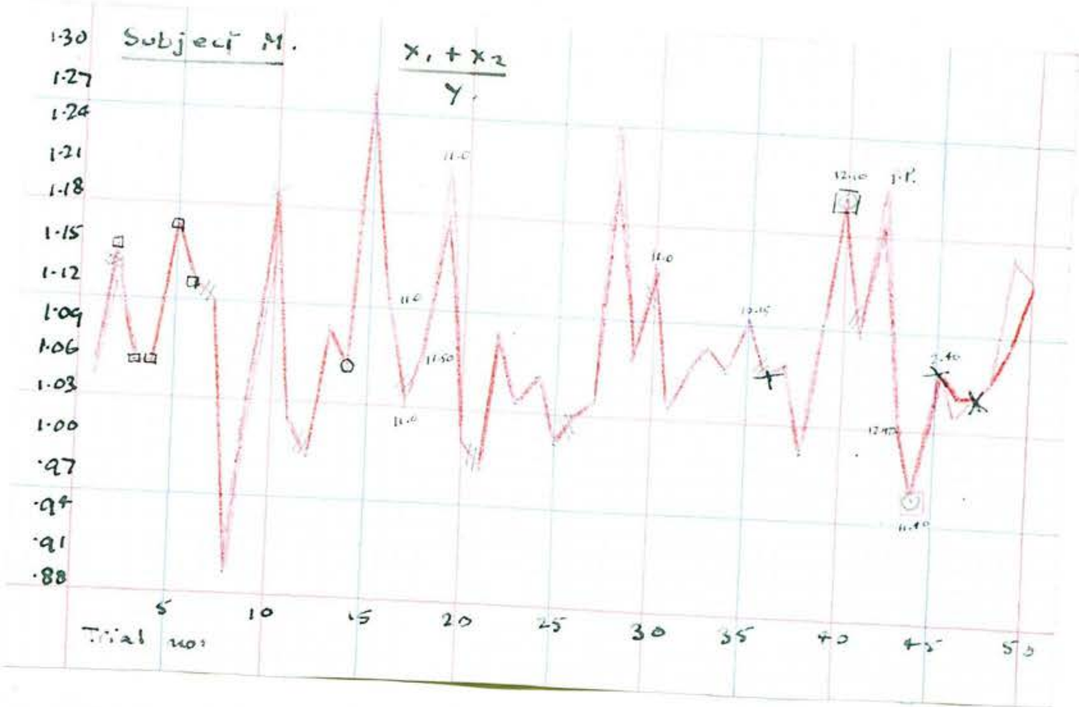
Subject M. Scores when all ws are counted as correct.

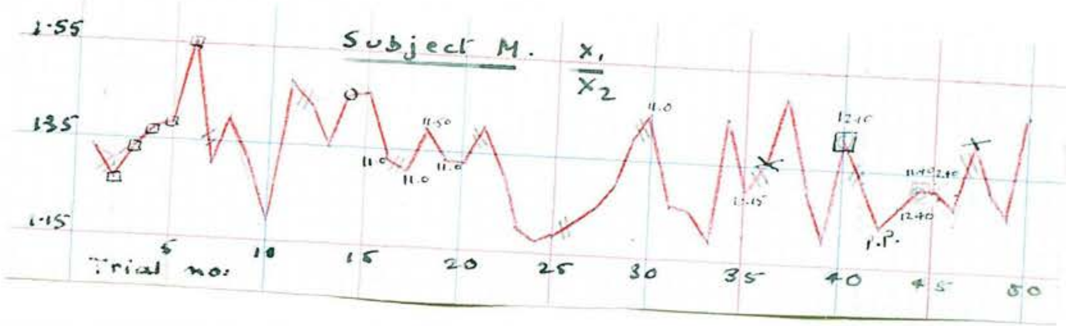
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
43	June 12	2.40 P.M.	43	34	75	1.03	1.26	2.41	Before examination. S.was up late the previous night but did not feel tired.
44	June 13	11.40 A.M.	47	36	81	1.02	1.31	2.47	After examination. S. said he felt cheerful. He had been writing very fast, and had been hurrying about since the examination and was very hot.
45	June 14	2.40 P.M.	47	36	78	1.06	1.31	2.52	
46	June 15	9.50 A.M.	41	34	70	1.07	1.21	2.38	
47	June 17	9.45 A.M.	44	31	71	1.06	1.42	2.66	Noise in X_1 and Y.
48	June 18	"	42	32	69	1.07	1.31	2.53	
49	June 19	"	43	34	70	1.10	1.26	2.49	
50	June 20	9.50 A.M.	47	32	69	1.14	1.47	2.83	

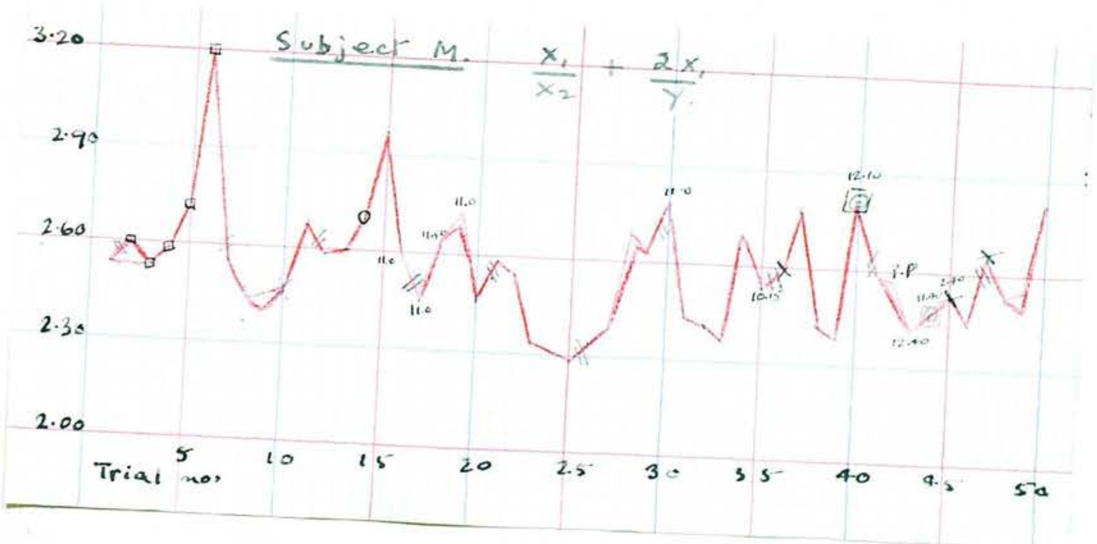
Subject M. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
2	29 (1)	23	46	1.13	1.26	2.52
9	38	29 (1)	66	1.02	1.31	2.46
13	42	31	67 (1)	1.09	1.45	2.70
19	44	33	63 (2)	1.22	1.33	2.73
28	44	34	62 (1)	1.26	1.29	2.71
42	43	35	64 (1)	1.22	1.23	2.57
46	41	32 (2)	70	1.04	1.28	2.45
49	43	34	66 (4)	1.17	1.26	2.56


Subject M. Speed.
Time of test 8.45 to 10 A.M. unless otherwise indicated.
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
5
10
15
20
25
30
35
40
45
50
Trial


Subject M.
$\frac{X_1 + X_2}{Y}$
1·30
1·27
1·24
1·21
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
·91
·88
Trial nos
5
10
15
20
25
30
35
40
45
50


Subject M.
$\frac{X_1}{X_2}$
1·55
1·35
1·15
Trial nos:
5
10
15
20
25
30
35
40
45
50


Subject M.
$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
3·20
2·90
2·60
2·30
2·00
Trial nos
5
10
15
20
25
30
35
40
45
50

Subject M. Introspections.

Trial 4. After X_2, S. said that it felt wrong and he must be worried. Later, he said he was worried all the week (trials 2 to 6 inclusive) about an interview or interviews for a post, but that from the day of trial 7 things were better.

Trial 15. S. made seven ordinary ws at the beginning of Y, then two reversed ones. When asked if he could account for this he said he thought it was because he was not concentrating, though he could not say what was in his mind. He was not aware of the error till after the sixth w ; then he realised that they were wrong, because they were too neat; he made a fresh start, but made two reversed ones in succession; he could not say why; he thought that perhaps it was to compensate for the error. In the pause between X_2 and Y he had been talking with great interest about an essay he had just written; this may have caused the distraction.

Trial 17. S. said he had a "bad spell" of reversed ws in Y. He was just beginning to think it easy when it became difficult.

Trial 21. S. said he thought the maxim "more haste, less speed" applied to the test; if he tried to be very quick he made fewer ws and they deteriorated. When asked if he meant that deterioration in/

in quality occurred, or that there was actually inability to make a w at all at times, he said that both occurred; the ws got worse and worse till a point was reached at which the hand stuck .... it was better not to get excited about speed but to concentrate on getting a free swing.

Trial 22. S. said he definitely felt it better now that he was aiming at a steady rate; he felt very steady in X_2. It was better not to hold the pencil too firmly.

Trial 23. S. said he counted "1 2 3" for the three parts of the w in X_2 and Y , and was conscious of an acceleration of this rhythm in Y.

Trial 24. S. said he was conscious of the rhythm "1 2 3", and thought he had done a great amount in X_2. In Y he began working in this rhythm; then he thought that the two ws made a unit, and got into difficulties towards the end of the third line through thinking this; he became able to work satisfactorily again when he thought of the ws as one continuous series, not in pairs. (The question suggests itself, whether the difficulty was due simply to the wandering of attention, or to the rhythm actually being broken by the attempt to put the ws in pairs.) When asked if he thought of the rhythm in X_1 too, he said he did.

Trial 25. S. said he got into the rhythm in the last/

last line of X_1, which he wrote more heavily, and he used it throughout after this, and felt it a great help, at any rate with reversed ws. It made it possible to begin a line with a reversed w, which he had previously been unable to do without feeling checked.

Trial 26. S. said it was much easier with the rhythm, and that the standard of the reversed ws was better. (This is on the whole true.)

Trial 28. S. said that he felt inhibited in X_1, that X_2 was easier, but that he had difficulties again at times in Y. He asked if using rhythm had made a great difference to the amount done in X_2 (he had already been told that it had made some), and was told that it had not made a great amount. He said he felt as if he was doing about twice as much.

Trial 31. S. said he got into the rhythm in the second last line of Y. (He appeared to hesitate at the end of every line in X_2.)

Trial 35. S. said he hesitated at the beginning of X_2, because he was going to make ordinary ws, then realised that this was wrong.

Trial 36. S. said he was slow at beginning X_1 because his mind was wandering. He felt Y to be in pairs - the reversed w came easily. He thought the "p" error occurred, because the pair came so easily, that he did another automatically.

Trial 37./

Trial 37. S. said he was very conscious of the break at the end of the line in X_1. He felt Y to be in pairs, but it did not seem to help.

Trial 38. S. said that, after the first w , Y formed itself into pairs, of which the first member was a reversed w .

Trial 44. S. said he needed to make no effort to write in X_2; he felt that the pencil was running away with him. (This seems to have been due either to writing fast in an examination shortly before, or to hurrying about, or to both).

Trial 45. S. said that a certain w in X_1 was made much more slowly than the others; he could not say why. Y was in pairs. He got distracted once through making a bad w .

Trial 46. S. said he was troubled in X_1, by the rhythm being broken at the end of the lines; he had to start the rhythm in each line afresh. In X_2 he found himself making the ws at the end of the line badly, so as to get back faster to the beginning of the next; this was not deliberate. There was no such difficulty in Y.

Subject N. General Discussion.

Subject N is a woman, aged twenty-one, who had had no previous practice at the test.

The graphs show that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ drop rapidly at the beginning of the period of testing, and then fluctuate about a more or less constant level. The score $\frac{X_1 + X_2}{Y}$ tends to rise. This is because the speed in Y tends to fall in the latter part of the testing; the highest speed in Y was reached at the thirteenth trial. In X_1, also, the highest speed was reached relatively early in the testing, namely at the twenty-third trial. As in the case of B, there is comparatively little improvement in the speed of X_1. There is some tendency for the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ to be low, when the test is done late in the morning. This seems to be partly due to X_1 tending to fall in speed, and partly to X_2 tending to rise. N said she felt she wrote more slowly, when the test was done at about one o'clock.

The majority of the errors were omissions of the hook of the ordinary w in X_1; consequently counting imperfect ws as errors usually raises the score. It makes a large difference to the score $\frac{X_1 + X_2}{Y}$ in trial 37.

After the fiftieth trial, N said she felt she worked faster when she thought about something else, and/

and also when other subjects were doing the test at the same time. Apart from this she gave no introspections.

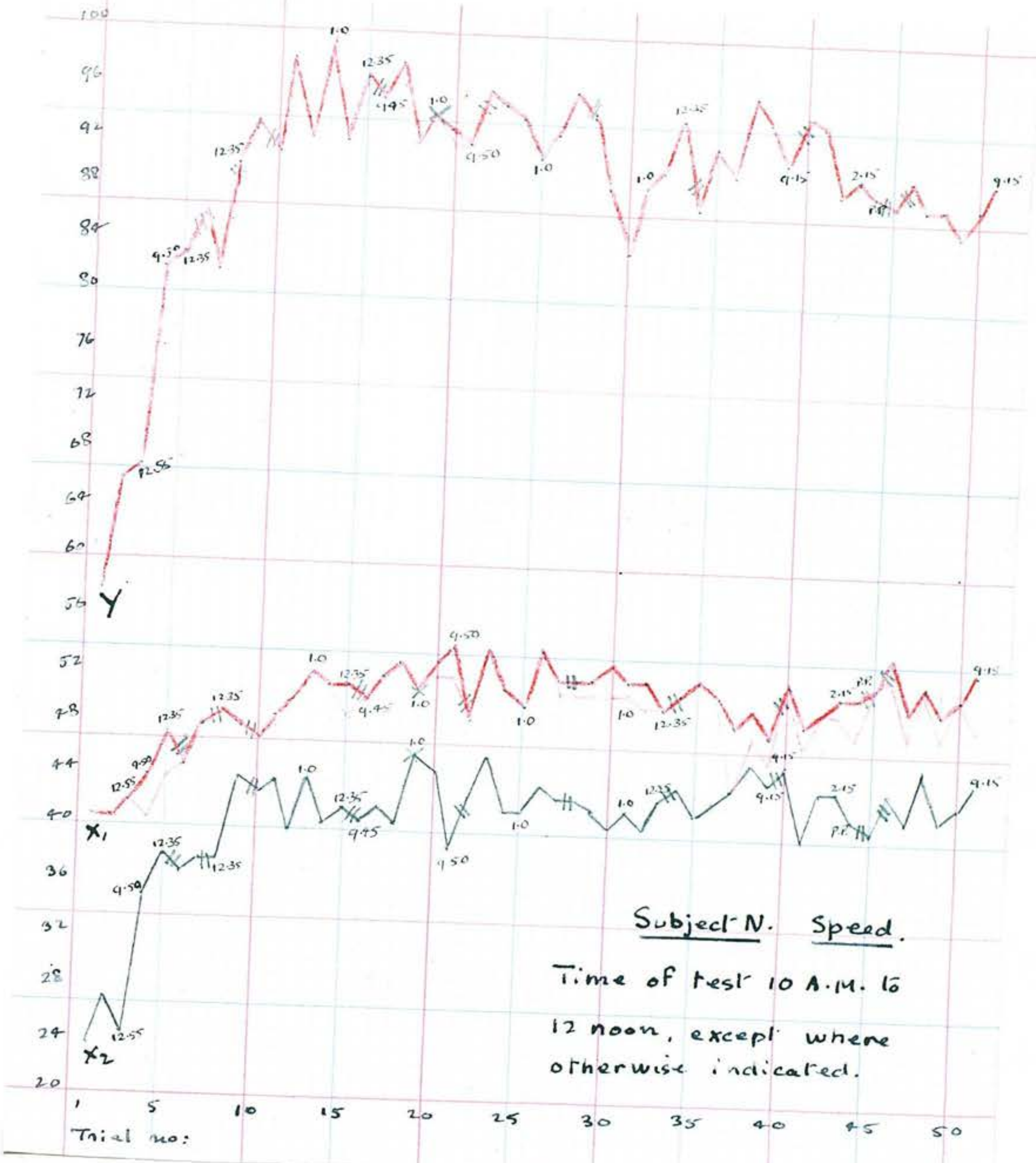
Subject N. Scores when all ws are counted as correct.

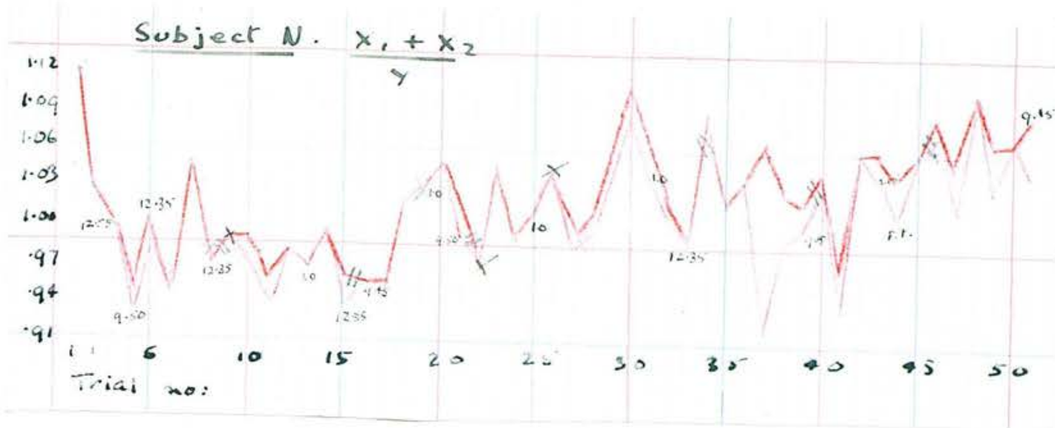
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
1	Ap:16	10.55 A.M.	41	24	58	1.12	1.71	3.12	
2	Ap:17	11.55 A.M.	41	27	66	1.03	1.52	2.76	
3	Ap:18	12.55 P.M.	42	25	67	1.00	1.68	2.93	
4	Ap:19	9.50 A.M.	44	35	82	.96	1.26	2.33	
5	Ap:20	12.35 P.M.	47	38	83	1.02	1.23	2.36	
6	Ap:22	11 A.M.	45	37	86	.95	1.22	2.27	
7	Ap:23	"	48	38	82	1.05	1.26	2.43	
8	Ap:25	12.55 P.M.	49	38	90	.97	1.29	2.38	
9	Ap:26	11 A.M.	48	44	93	.99	1.09	2.12	
10	Ap:29	"	47	43	91	.99	1.09	2.12	45 secs; between X_1 and X_2. Noise in X_2 and Y.
11	Ap:30	"	49	44	98	.95	1.11	2.11	
12	May 1	11.55 A.M.	50	40	92	.98	1.25	2.34	
13	May 2	1 P.M.	52	44	99	.97	1.18	2.23	
14	May 3	11 A.M.	51	41	92	1.00	1.24	2.35	
15	May 4	12.35 P.M.	51	42	97	.96	1.21	2.26	
16	May 6	9.45 A.M.	50	41	95	.96	1.22	2.27	
17	May 7	10.55 A.M.	52	42	98	.96	1.24	2.30	S. up late last night.
18	May 8	11.50 A.M.	53	41	92	1.02	1.29	2.44	
19	May 9	1 P.M.	51	46	94	1.03	1.11	2.20	
20	May 10	10.55 A.M.	53	45	93	1.05	1.18	2.32	
(21	May 11	9.50 A.M.	54	39	92	1.01	1.38	2.55)	Discarded on the ground that the early hour may have affected the score.
22	May 13	11 A.M.	49	43	96	.96	1.14	2.16	Noise in Y.
23	May 14	"	54	46	95	1.05	1.17	2.31	
24	May 15	11.55 A.M.	51	42	94	.99	1.21	2.30	Noise in X_2 and Y.
25	May 16	1 P.M.	50	42	91	1.01	1.19	2.29	
26	May 17	11 A.M.	54	44	93	1.05	1.23	2.39	Noise in Y .

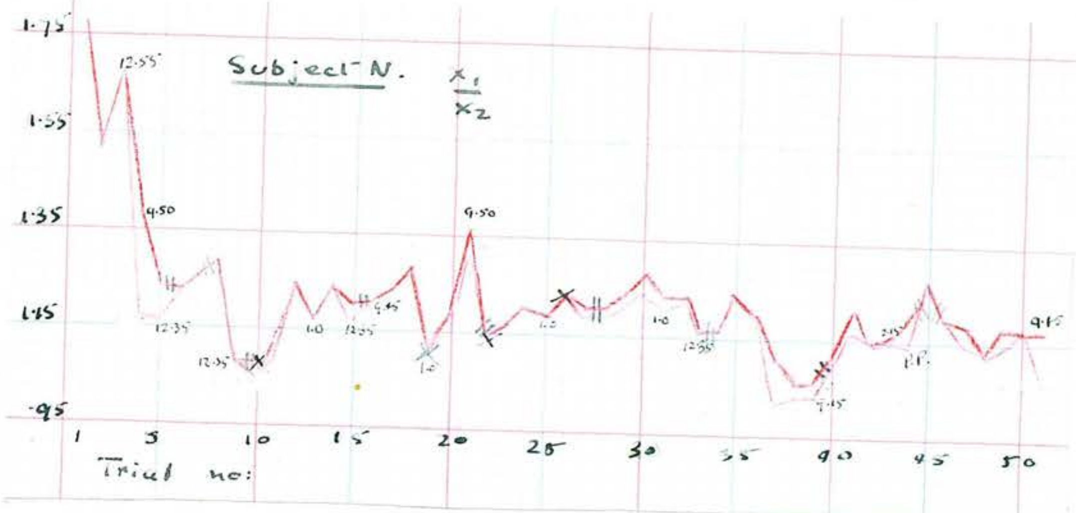
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
27	May 18	10.30 A.M.	52	43	96	.99	1.21	2.29	
28	May 20	10.10 A.M.	52	43	94	1.01	1.21	2.32	
29	May 21	10 A.M.	52	42	89	1.06	1.24	2.41	
30	May 22	11.55 A.M.	53	41	84	1.12	1.29	2.55	
31	May 23	1 P.M.	52	42	89	1.06	1.24	2.41	
32	May 24	11 A.M.	52	41	90	1.02	1.24	2.37	Noise in X_1.
33	May 25	12.35 P.M.	50	43	94	.99	1.16	2.22	
34	May 27	10.55 A.M.	51	44	87	1.09	1.16	2.33	
35	May 28	10.40 A.M.	52	42	92	1.02	1.24	2.37	
36	May 29	11.55 A.M.	51	43	90	1.04	1.19	2.32	
37	May 30	11 A.M.	49	44	96	.97	1.11	2.13	
38	May 31	"	50	47	94	1.03	1.06	2.12	
39	June 1	9.15 A.M.	48	45	91	1.02	1.07	2.12	
40	June 3	11 A.M.	52	46	94	1.04	1.13	2.24	Some ws in X_1 very small.
41	June 4	11.55 A.M.	49	40	93	.96	1.225	2.275	
42	June 5	"	50	44	89	1.06	1.14	2.26	
43	June 6	2.15 P.M.	51	44	90	1.06	1.16	2.29	
(44	June 7	11.15 A.M.	51	42	89	1.04	1.21	2.36)	Done with pressure pencil. After examination; S. said the paper was fairly easy but long, so had probably been writing fast; she seemed excited.
(45	June 10	11.15 A.M.	52	41	88	1.06	1.27	2.45)	
46	June 12	11.30 A.M.	54	44	90	1.09	1.23	2.43	
47	June 13	12 Noon	50	42	88	1.05	1.19	2.33	
48	June 14	11.30 A.M.	52	46	88	1.11	1.13	2.31	
49	June 15	11.40 A.M.	50	42	86	1.07	1.19	2.35	
50	June 16	10.25 A.M.	51	43	88	1.07	1.19	2.35	
51	June 17	9.15 A.M.	53	45	90	1.09	1.18	2.36	

Subject N. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
4	41 (3)	35	82	.93	1.17	2.17
5	44 (3)	38	83	.99	1.16	2.22
10	45 (2)	43	91	.97	1.05	2.04
11	48 (1)	44	98	.94	1.09	2.07
15	49 (2)	42	97	.94	1.17	2.18
20	52 (1)	45	92 (1)	1.05	1.16	2.29
(21	52 (2)	39	92	.99	1.33	2.46)
27	51 (1)	43	96	.98	1.19	2.25
28	51 (1)	43	94	1.00	1.19	2.28
29	51 (1)	42	89	1.04	1.21	2.36
30	51 (2)	41	84	1.10	1.24	2.45
31	51 (1)	42	89	1.04	1.21	2.36
32	50 (1)	41	90	1.01	1.22	2.33
37	44 (5)	44	96	.92	1.00	1.92
38	48 (2)	47	94	1.01	1.02	2.04
39	46 (2)	45	91	1.00	1.02	2.03
40	51 (1)	46	94	1.03	1.11	2.20
41	47 (2)	40	93	.94	1.175	2.185
43	50 (1)	44	90	1.04	1.14	2.25
(44	48 (3)	42	89	1.01	1.14	2.22)
46	53 (1)	44	90	1.08	1.20	2.38
47	48 (2)	42	88	1.02	1.14	2.23
49	48 (2)	42	86	1.05	1.14	2.26
51	49 (4)	45	90	1.04	1.09	2.18


Subject N. Speed.
Time of test 10 A.M. to 12 noon, except where otherwise indicated.
Trial no:
Y
X_1
X_2


Subject N. $\frac{X_1 + X_2}{Y}$
Trial no: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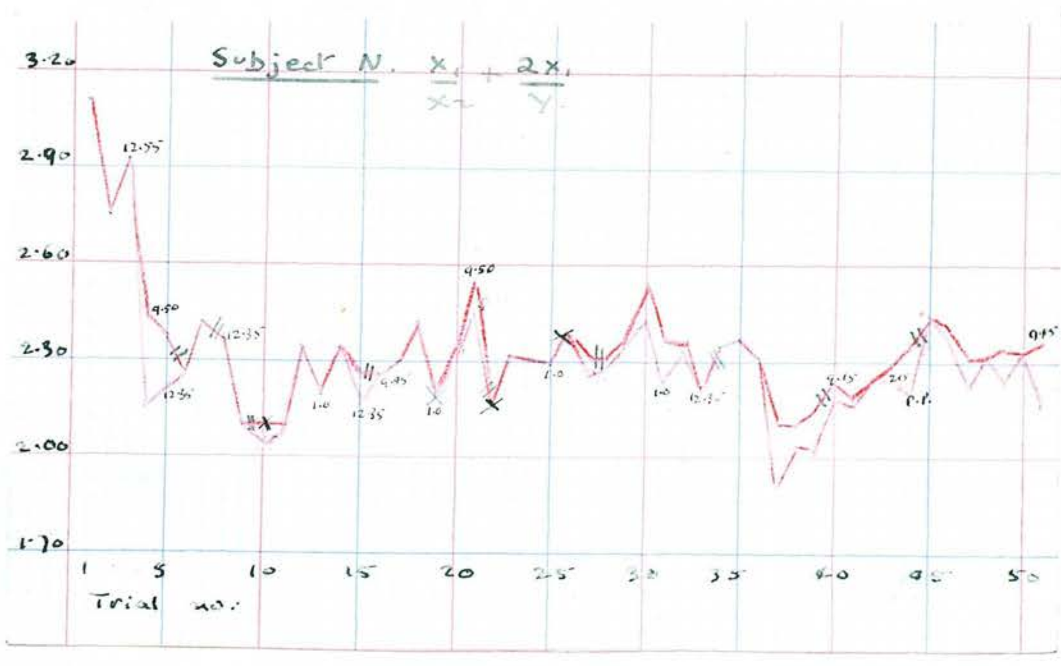
Trial no:


Subject N. $\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Trial no:

Subject O.

Subject O is a woman, aged twenty. She did ten trials at the test, at her maximum speed, in Experiment II.

The graphs show that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ drop fairly rapidly in the early part of Experiment III, up to about the tenth trial, then tend to rise again very gradually. In Experiment II, they do not change in any consistent direction. The score $\frac{X_1 + X_2}{Y}$ perhaps tends to fall in Experiment II, and fluctuates about an approximately constant level in Experiment III. The period of rapid writing preceding trial 47 does not seem to have had any pronounced effect on speed. There seems to be some tendency for higher speeds to be reached, particularly in Y, when the test is done late in the morning.

Subject O gave only a few short introspections.

Subject O. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov.9	3-4 P.M.	34	25	59	1.00	1.36	2.51	S. found Y rather easier than the other two parts.
2	"	"	37	30	71	.94	1.23	2.27	
3	Nov.16	"	43	32	80	.94	1.34	2.415	In X_2 S. felt she had little control over the pencil.
4	"	"	44	35	87	.91	1.26	2.27	
5	"	"	46	32	74	1.05	1.44	2.68	S. became rather muddled as to the order about the middle of Y.
6	Nov.23	"	45	32	87	.89	1.41	2.44	
7	"	"	49	34	88	.94	1.44	2.55	S. felt a lack of control over the pencil in X_2, but not when doing the reversed ws in Y.
8	Nov.30	"	45	35	89	.90	1.29	2.30	In X_1, S. felt her hand to be moving very smoothly.
9	"	"	51	36	104	.84	1.42	2.40	
10	"	"	50	42	105	.88	1.19	2.14	
Experiment III.									
1	Ap:16	10.55 A.M.	44	31	79	.95	1.42	2.53	
2	Ap:17	"	48	32	77	1.04	1.50	2.75	
3	Ap:18	11 A.M.	47	36	86	.97	1.31	2.40	
4	Ap:19	9.50 A.M.	52	37	98	.91	1.41	2.47	

Subject O. Scores when imperfect ws are counted as errors.

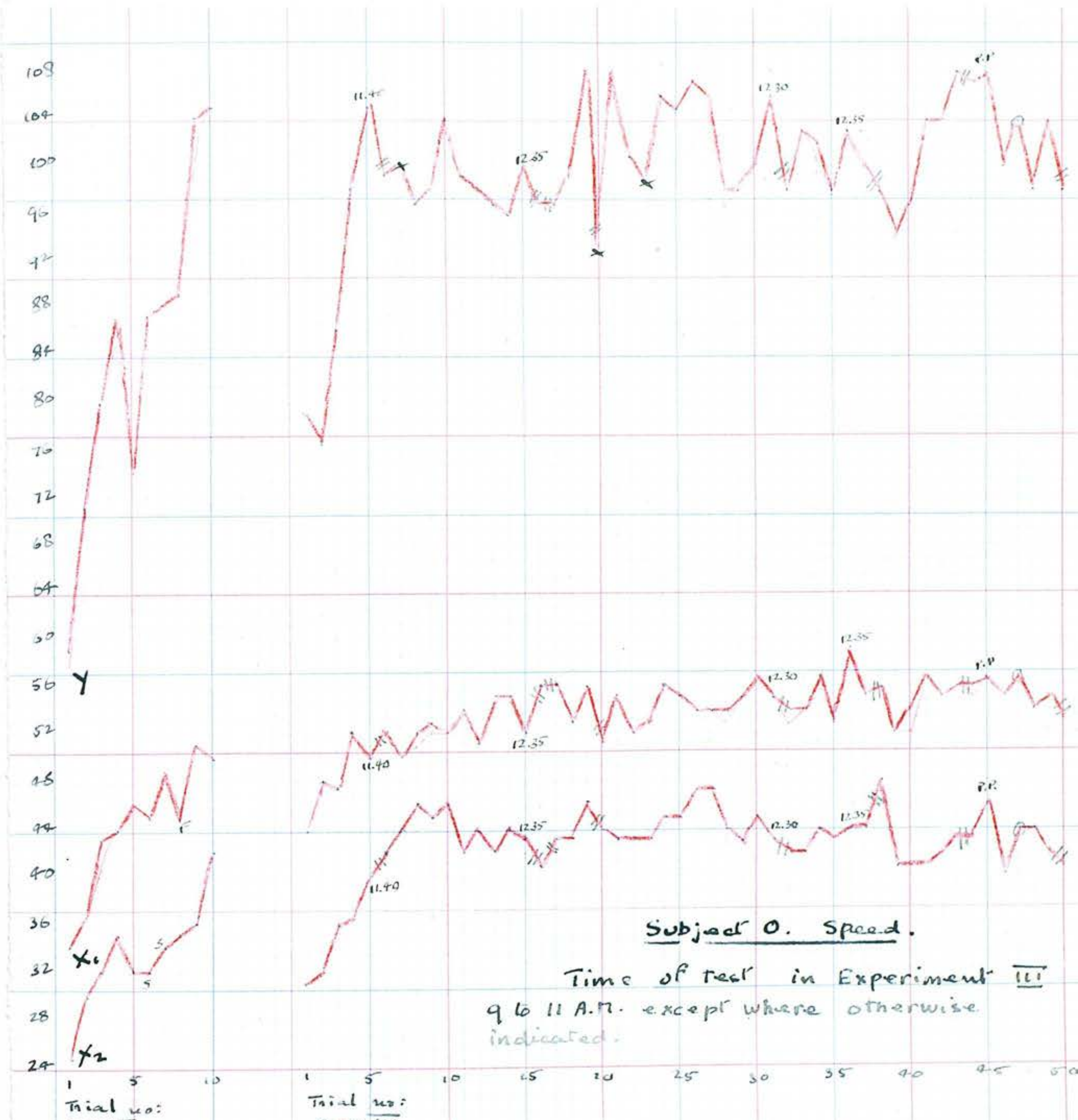
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
5	Ap:20	11.40 A.M.	50	40	105	.86	1.25	2.20	
6	Ap:23	11 A.M.	52	42	99	.95	1.24	2.29	
7	Ap:24	"	50	44	100	.94	1.14	2.14	Noise in Y .
8	Ap:25	"	52	46	97	1.01	1.13	2.20	
9	Ap:26	"	53	45	98	1.00	1.18	2.26	
10	Ap:29	"	52	46	104	.94	1.13	2.13	45 secs. between X_1 and X_2 Noise in X_2 and Y.
11	Ap:30	10.55 A.M.	54	42	99	.97	1.29	2.38	
12	May 1	11 A.M.	51	44	98	.97	1.16	2.20	
13	May 2	"	55	42	97	1.00	1.31	2.44	
14	May 3	"	55	44	96	1.03	1.25	2.40	
15	May 4	12.35 P.M.	52	43	100	.95	1.21	2.25	
(16	May 7	11 A.M.	56	41	97	1.00	1.37	2.52)	
17	May 9	"	56	43	97	1.02	1.30	2.45	
18	May 10	10.55 A.M.	53	43	99	.97	1.23	2.30	
19	May 11	9.50 A.M.	56	46	108	.94	1.22	2.26	
20	May 13	11 A.M.	51	44	93	1.02	1.16	2.26	Noise in Y.
21	May 14	10.55 A.M.	55	43	108	.91	1.28	2.30	
22	May 15	11 A.M.	52	43	102	.93	1.21	2.23	
23	May 16	"	53	43	100	.96	1.23	2.29	
24	May 17	"	56	45	106	.95	1.24	2.30	Noise in Y.
25	May 18	11.5 A.M.	55	45	105	.95	1.22	2.29	
26	May 20	10.30 A.M.	54	47	107	.94	1.15	2.16	
27	May 21	10.15 A.M.	54	47	106	.95	1.15	2.17	
28	May 22	11 A.M.	54	44	98	1.00	1.23	2.33	
29	May 23	10.55 A.M.	55	43	98	1.00	1.28	2.40	

Subject O. Scores when imperfect ws are counted as errors.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
30	May 24	11 A.M.	57	45	100	1.02	1.27	2.41	Noise in X_2.
31	May 25	12.30 P.M.	55	43	106	.92	1.28	2.32	
32	May 27	11 A.M.	54	42	98	.98	1.29	2.39	
33	May 28	"	54	42	103	.93	1.29	2.34	
34	May 29	11.55 A.M.	57	44	102	.99	1.30	2.42	
35	May 30	11 A.M.	53	43	98	.98	1.23	2.31	
36	May 31	11.15 A.M	59	44	103	1.00	1.34	2.49	
37	June 1	12.35 P.M.	55	44	100	.99	1.25	2.35	
(38	June 3	11 A.M.	56	48	98	1.06	1.17	2.31)	
39	June 4	"	52	41	94	.99	1.27	2.38	
40	June 5	11.15 A.M.	54	41	97	.98	1.32	2.43	
41	June 6	11 A.M.	57	41	104	.94	1.39	2.49	
42	June 7	11.45 A.M.	55	42	104	.93	1.31	2.37	Before examination.
43	June 8	10.5 A.M.	56	44	108	.93	1.27	2.31	
44	June 10	11 A.M.	56	43	107	.93	1.30	2.35	Slight noise in Y.
(45	June 11	11.10 A.M.	57	46	108	.95	1.24	2.30)	Done with pressure pencil.
46	June 12	10.50 A.M.	55	40	100	.95	1.375	2.475	
47	June 13	11.10 A.M.	57	44	104	.97	1.30	2.40	After examination: S. had been writing very fast.
48	June 14	11 A.M.	54	44	98	1.00	1.23	2.33	
49	June 15	10 A.M.	55	42	104	.93	1.31	2.37	
50	June 19	11.5 A.M.	53	41	98	.96	1.29	2.37	

Subject O. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
1	34	25	58 (1)	1.02	1.36	2.53
3	41 (2)	32	80	.91	1.28	2.305
4	44	35	86 (1)	.92	1.26	2.28
9	51	36	103 (1)	.85	1.42	2.41
Experiment III.						
8	51 (1)	46	97	1.00	1.11	2.16
9	52 (1)	45	98	.99	1.16	2.22
28	53 (1)	44	97 (1)	1.00	1.20	2.29
32	53 (1)	42	98	.97	1.26	2.34
34	56 (1)	44	101 (1)	.99	1.27	2.38
40	52 (2)	41	97	.96	1.27	2.34
44	55 (1)	43	107	.92	1.28	2.31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28
24
Y
X1
X2
11.40
12.35
12.30
12.35
1 P.M.
1 5 10
1 5 10 15 20 25 30 35 40 45 50
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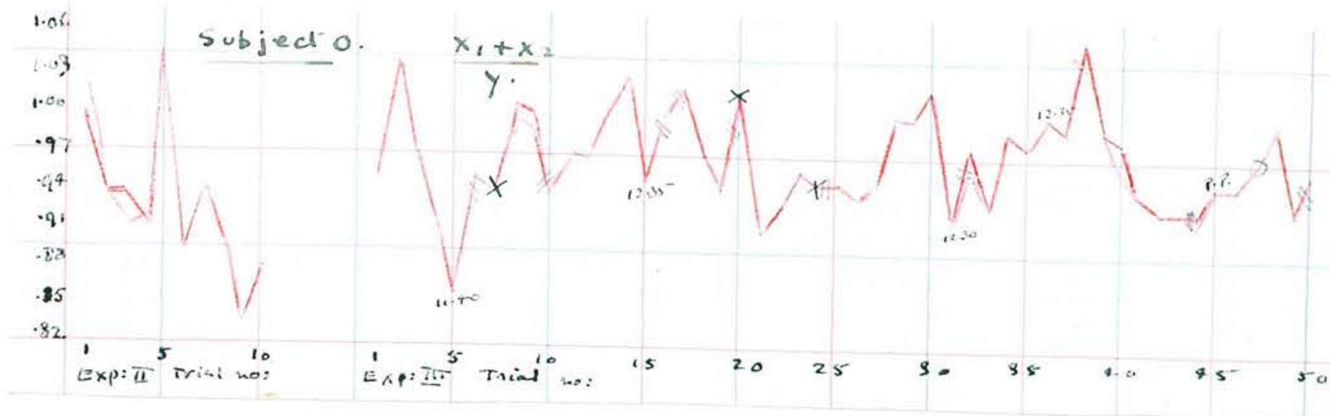
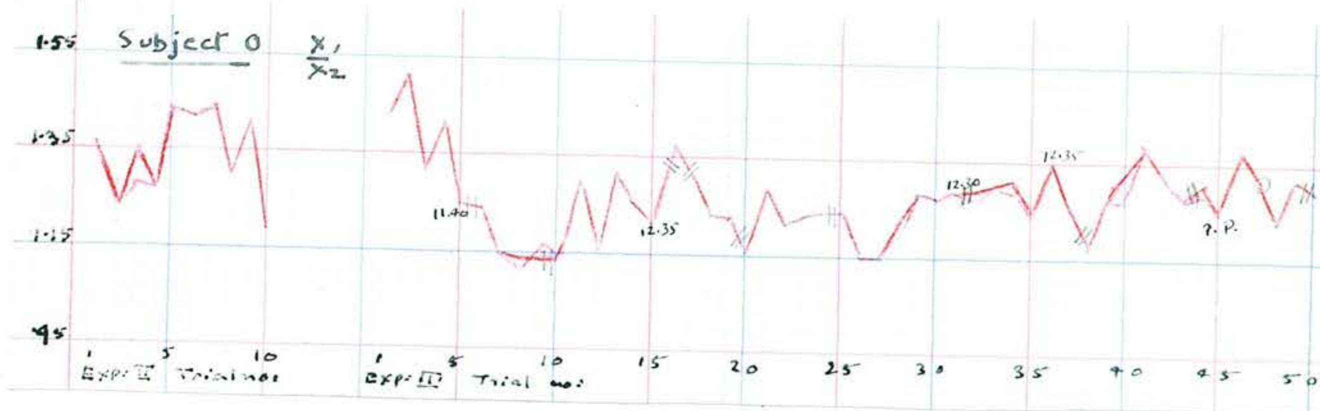
Exp: II
Trial no:
Exp: III
Subject O. Speed.
Time of test in Experiment III
9 to 11 A.M. except where otherwise indicated.


Subject O.
$\frac{x_1+x_2}{y}$
Exp: II Trial no:
Exp: III Trial no:


Subject O
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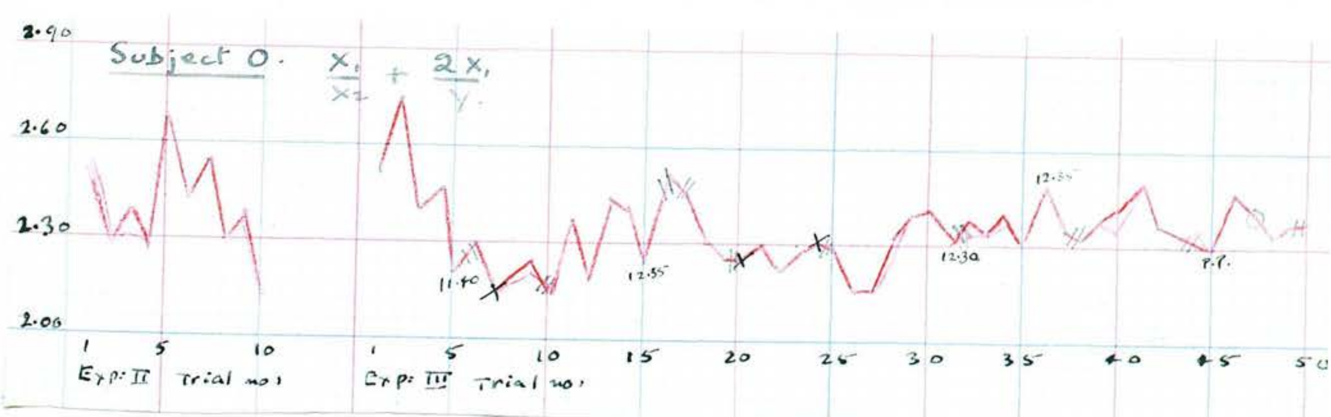
Exp: II Trial no:
Exp: III Trial no:


Subject O.
$\frac{x_1}{x_2} + \frac{2x_1}{y}$
Exp: II Trial no:
Exp: III Trial no:

Subject P. General Discussion.

Subject P is a man, aged twenty-five. He was a member of the Friday Group in Experiment II, but did not complete the experiment. He is of interest, both because there is some evidence that he is emotionally unstable, and because it is possible to connect certain changes in his score with changes in his style of writing.

Subject P was absent from the university, on account of a "nervous breakdown", during the period which included the last day of Experiment II. Unstable individuals are supposed by Pinard[30] and Cattell[5] to have extremely high or low perseveration scores. Subject P began as a very high perseverator - in fact he at first failed completely to make a reversed w - and ended as a very low one. It is a little difficult to know what to make of this. He has one quality usually regarded as characteristic of high perseverators; he can concentrate on brain-work in the midst of distraction, and is, in fact, very absent-minded at times. He is also apt to be unpunctual; he was late for the test nearly every day.

The graphs show, that the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ fall steeply at the beginning of Experiment III, and more gradually as far as the tenth trial. They then tend to rise gradually; there is a distinct rise, in the/

the score $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, to a higher plateau at about the thirtieth trial. The score $\frac{X_1 + X_2}{Y}$ tends to rise very slightly in the course of the experiment. Up to the twenty-fifth trial of Experiment III the ordinary ws had a long initial upstroke. This began to be omitted at times from the twenty-sixth trial onwards, and was practically always omitted from the thirty-fifth. This change may possibly account for the rise of the speed in X_1 and Y to a higher plateau at trials 32 and 29 respectively, and thus for the increase in the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ at about this point. The maximum speed in X_1 was reached in a trial in which the ordinary ws were unusually flat and low in shape. The maximum speed in Y was reached on the trial following that, on which P said he had got into a rhythm, but also in a trial following a period of rapid writing, so that it is impossible to suggest to which of these factors the high speed was due. An attempt to form the reversed ws more carefully appears to have caused a decrease in the speed of X_2 and Y in trials 44 and 45.

In addition to the fact, that it is thus possible often to connect the perseveration score in detail with the style of writing, the lowness of the mean perseveration score, for the trials from the sixteenth to the fiftieth, is almost certainly due to the fact, that while the reversed ws were pronouncedly tilted in/

in a backhand direction, and carelessly formed, the ordinary ones were unusually pretty and elaborate. Subject P made a remark once which showed that he prided himself on the beauty of his writing.

Subject P was aware that the perseveration score of mental patients varies with their emotional state, and this knowledge prompted him to give some introspections as to his own emotional moods. These were not systematic enough to enable any final conclusion to be drawn, but there appears to be some tendency for bad moods to be accompanied by a lowering of speed in all the parts of the test. The perseveration score is not, however, affected in any consistent direction.

Subject P. Scores when all ws are counted as correct.*

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov.16	3-4 P.M.	6 (6)	0 (20)	33 (33)	-	-	-	In X1 S. made a complicated mixture of ordinary and reversed ws, because he misunderstood the instructions. In X_2 and Y all the reversed ws had the hook at the wrong end.
2	Nov.16	3-4 P.M.	42	0 (24)	34 (34)	1.24	-	-	S. put all the hooks of the reversed ws on the wrong end, and wrote X_2 from right to left.
3	Nov.16	3-4 P.M.	39	0 (28)	36 (36)	1.08	-	-	S. put all the hooks of the reversed ws on the wrong end.
4	Nov.23	3-4 P.M.	43	1 (30)	38 (35)	1.16	43.00	45.26	S. put almost all the hooks of the reversed ws on the wrong end. One "p" error.
5	Nov.23	3-4 P.M.	40	0 (33)	42 (41)	.95	-	-	S. put all the hooks of the reversed ws on the wrong end.

* Except actual failures to follow instructions, which are extremely numerous in Experiment II.

Subject P. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment III.									
1	Ap:16	3.5 P.M.	40	28	68	1.00	1.43	2.61	
2	Ap:17	3.10 P.M.	36	27	66	.95	1.33	2.42	S. was criticised for his errors before the test. He said he was in a bad mood, as he had just been turned out of his lodgings; he felt his ws were bad.
3	Ap:19	3.5 P.M.	38	34	84	.86	1.12	2.02	
4	Ap:20	12.45 P.M.	43	41	93	.90	1.05	1.97	S. said he felt he could not do it well. When asked if the errors were due to trying to increase speed, or to something for which he could not account, he said he had "off-days" in handwriting.
5	Ap:22	3 P.M.	39	42	90	.90	.93	1.80	
6	Ap:23	"	43	45	97	.91	.96	1.85	
7	Ap:24	3.15 P.M.	44	46	98	.92	.96	1.86	S. was praised before the test for making fewer errors.
8	Ap:26	3.5 P.M.	42	44	94	.91	.95	1.84	
9	Ap:27	11.35 A.M.	45	44	98	.91	1.02	1.94	
10	Ap:30	3.10 P.M.	40	44	98	.86	.91	1.73	

Subject P. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
11	May 1	3.30 P.M.	45	52	103	.94	.87	1.74	
12	May 2	3.5 P.M.	45	51	107	.90	.88	1.72	
13	May 3	3.10 P.M.	45	51	101	.95	.88	1.77	S. had a headache.
14	May 4	12.40 P.M.	45	51	101	.95	.88	1.77	
15	May 7	3.15 P.M.	42	49	97	.94	.86	1.74	
16	May 8	3.30 P.M.	45	51	100	.96	.88	1.78	
17	May 9	3.P.M.	46	57	109	.94	.81	1.65	
18	May 10	3.15 P.M.	42	47	98	.91	.89	1.75	
19	May 14	"	44	46	97	.93	.96	1.87	
20	May 15	"	45	48	98	.95	.94	1.86	
21	May 16	3.5 P.M.	47	47	102	.92	1.00	1.92	
22	May 17	3.10 P.M.	43	47	98	.92	.91	1.79	35 seconds' pause between X_2 and Y. S. depressed.
23	May 18	12.30 P.M.	46	49	103	.92	.94	1.83	S. tired owing to late night, but was nevertheless feeling cheerful.
24	May 20	3 P.M.	44	46	96	.94	.96	1.88	
25	May 21	3.25 P.M.	44	44	105	.84	1.00	1.84	
26	May 22	3.5 P.M.	44	45	97	.92	.98	1.89	
27	May 23	3.20 P.M.	47	46	103	.90	1.02	1.93	
28	May 24	"	45	49	105	.90	.92	1.78	S. had a bad headache.
29	May 25	12.40 P.M.	47	50	112	.87	.94	1.78	Noise in Y. S. said he was in a hurry and that this disturbed him in X_1

Subject P. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
30	May 28	3.5 P.M.	48	50	115	.85	.96	1.79	
31	May 29	3.45 P.M.	46	49	107	.90	.94	1.80	E. spoke a little angrily to S. before the test because he was very late. He said he did not settle down till the middle of X_1
32	May 30	3 P.M.	53	52	111	.95	1.02	1.97	
33	May 31	3.15 P.M.	54	55	118	.92	.98	1.90	40 secs: pause between X_2 and Y.
34	June 1	12.40 P.M.	53	54	108	.99	.98	1.96	S. said he had got into a rhythm in Y and thought he had made a great many ws.
35	June 3	3.5 P.M.	56	54	121	.91	1.04	1.97	ws smaller than usual; S. thought that this was because his wrist was tired from taking notes fast.
36	June 4	3.5 P.M.	55	53	117	.92	1.04	1.98	
37	June 5	"	53	53	113	.94	1.00	1.94	S. was up late the previous night, and said he was mentally tired owing to an examination that morning. He did Y mechanically, and thought about something else.

Subject P. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
38	June 6	3.15 P.M.	53	51	112	.93	1.04	1.99	S. said that he had just been asleep and that his brain felt numb; he had difficulty in "making the connection between brain and hand, especially in X_1. In Y, he had difficulty as to how to hold his pencil.
39	June 7	3.10 P.M.	54	54	110	.98	1.00	1.98	S. very tired.
(40	June 10	3.15 P.M.	59	56	118	.97	1.05	2.05)	Discarded on the ground that the interval may have affected the score. The ws in X_1 are unusually low and flat.
41	June 11	3 P.M.	54	53	114	.94	1.02	1.97	
42	June 12	3.35 P.M.	52	53	112	.94	.98	1.91	After examination; S. thought he had done badly; he said that his nerves were on edge and the ws would not "go"
43	June 13	3.25 P.M.	55	53	108	1.00	1.04	2.06	
44	June 14	3.15 P.M.	54	52	104	1.02	1.04	2.08	S. said he had improved the quality of his reversed ws. This was true of Y but not of X_2.
(45	June 15	12.10 P.M.	56	49	103	1.02	1.14	2.23)	Discarded on the ground that the earlier hour may have affected the score. S. said he tried to keep his reversed ws straighter; he found it difficult in X_2 but easier in Y.

Subject P. Scores when all ws are counted as correct.

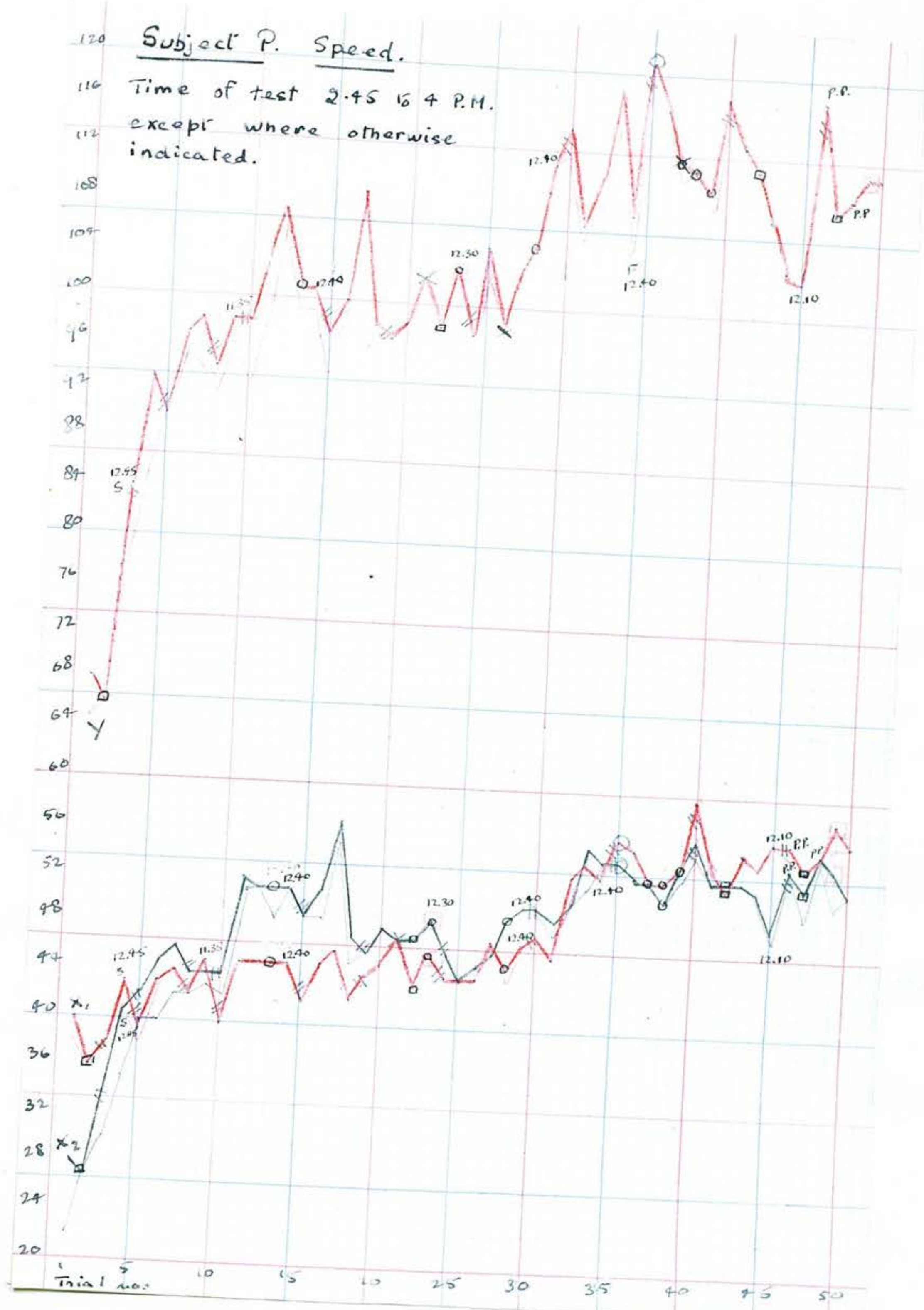
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
(46	June 17	3.5 P.M.	56	54	118	.93	1.04	1.99)	Done with pressure pencil.
47	June 18	3.20 P.M.	54	52	109	.97	1.04	2.03	S's eyes sore. He said he had just been talking about a painful subject.
(48	June 19	3 P.M.	55	55	110	1.00	1.00	2.00)	Done with pressure pencil.
49	June 20	3.15 P.M.	58	54	112	1.00	1.07	2.09	S. said he was feeling cheerful.
50	June 21	2.50 P.M.	56	52	112	.96	1.08	2.08	S. appeared hot.

Subject P. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
2	20 (22)	0 (24)	20 (48)	(1.00)	-	-
3	39	0 (28)	29 (43)	(1.34)	-	-
4	35 (8)	1 (30)	31 (42)	(1.16	35.00	37.26)
5	37 (3)	0 (33)	42 (41)	(.88)	-	-
Experiment III.						
1	38 (2)	22 (6)	65 (3)	.92	1.73	2.90
3	38	30 (4)	78 (6)	.87	1.27	2.24
4	41 (3)	35 (6)	85 (8)	.89	1.17	2.13
5	38 (1)	40 (2)	90	.87	.95	1.79
6	43	40 (5)	95 (2)	.87	1.075	1.985
7	44	42 (4)	94 (4)	.91	1.05	1.99
8	42	42 (2)	92 (2)	.91	1.00	1.91
9	45	43 (1)	96 (2)	.92	1.05	1.99
10	40	42 (2)	93 (5)	.88	.95	1.81
11	45	51 (1)	99 (4)	.97	.88	1.79
12	45	51	106 (1)	.91	.88	1.73
13	45	49 (2)	99 (2)	.95	.92	1.83
14	45	51	99 (2)	.97	.88	1.79
15	42	49	94 (3)	.97	.86	1.75
16	45	49 (2)	100	.94	.92	1.82
17	46	55 (2)	109	.93	.84	1.68

Subject P. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment III.						
18	42	45 (2)	98	.89	.93	1.79
25	44	44	104 (1)	.85	1.00	1.85
28	44 (1)	49	105	.89	.90	1.74
30	48	50	113 (2)	.87	.96	1.81
31	46	48 (1)	106 (1)	.89	.96	1.83
32	52 (1)	52	110 (1)	.95	1.00	1.95
33	54	52 (3)	118	.90	1.04	1.96
34	53	54	105 (3)	1.02	.98	1.99
37	53	53	111 (2)	.95	1.00	1.95
39	54	53 (1)	109 (1)	.98	1.02	2.01
(40	59	55 (1)	118	.97	1.07	2.07)
(45	56	48 (1)	103	1.01	1.17	2.26)
(46	55 (1)	54	118	.92	1.02	1.95)
47	54	50 (2)	109	.95	1.08	2.07
49	56 (2)	53 (1)	112	.97	1.06	2.06


Subject P. Speed.
Time of test 2.45 to 4 P.M.
except where otherwise
indicated.
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100
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76
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Trial nos.
5
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12.45
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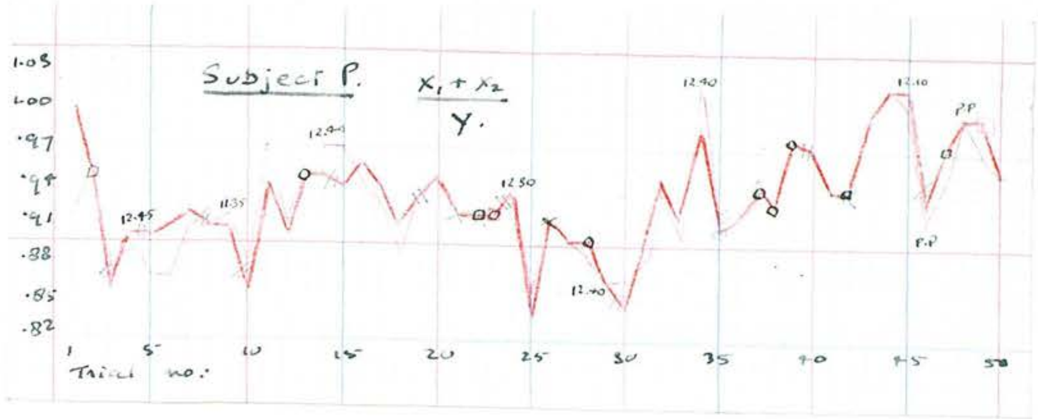
12.30
12.10
P.P.
X1
X2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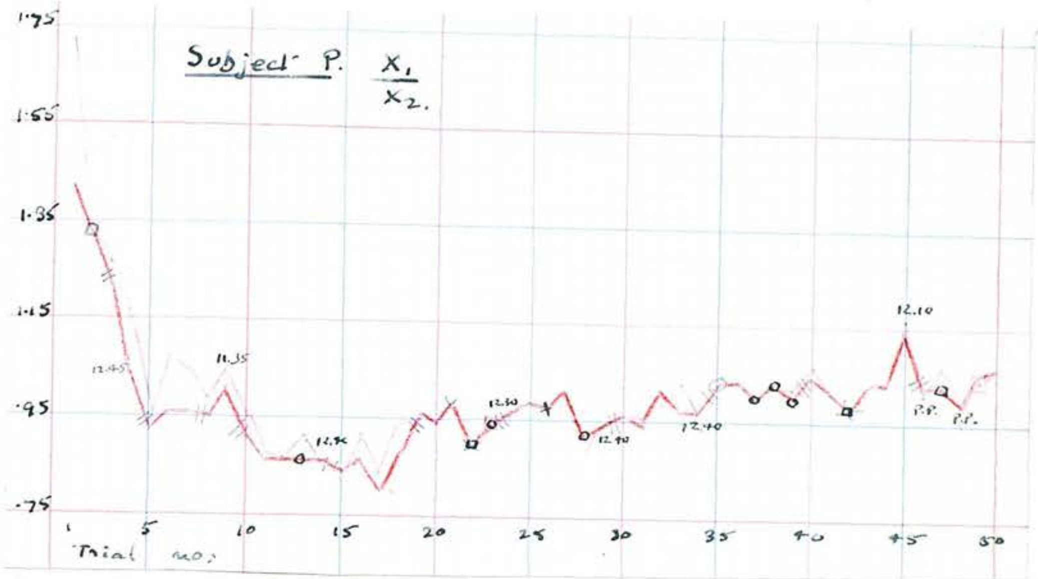
1.00
.97
.94
.91
.88
.85
.82
Trial no: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$\frac{X_1}{X_2}$
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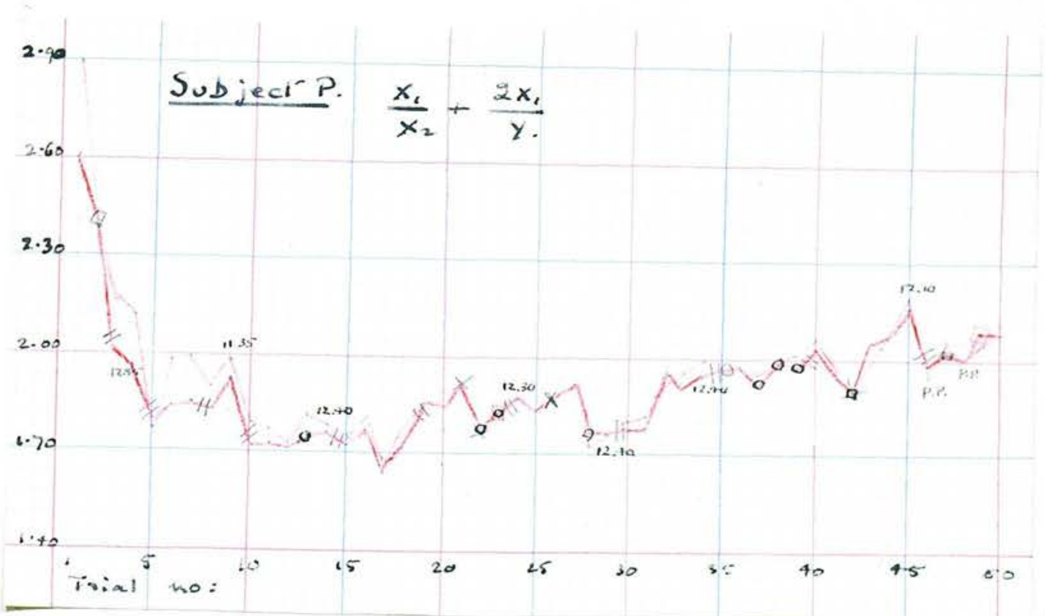
1.55
1.35
1.15
.95
.75
Trial no:


Subject P.
$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
2.90
2.60
2.30
2.00
1.70
1.40
Trial no:

Subject Q. General Discussion.

Subject Q is a woman, aged nineteen, who had done ten previous trials at the test, at her maximum speed, in Experiment II.

The graphs show that the perseveration score, by all the methods of scoring, decreased pronouncedly during Experiment II. In Experiment III, the scores $\frac{X_1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$ continued to decrease very gradually right to the end, while the score $\frac{X_1 + X_2}{Y}$ fluctuated about an approximately constant level, somewhat lower than that, about which it seemed to be fluctuating by the end of Experiment II.

The size of Subject Q's ws varied considerably at different trials, but this did not appear to have any connection with the score.

Subject Q gave only a few short introspections.

Subject Q. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
Experiment II.									
1	Nov.9	3-4 P.M.	35	19	39	1.39	1.84	3.63	
2	"	"	39	24	54	1.17	1.625	3.065	
3	Nov:16	"	37	25	62	1.00	1.48	2.67	
4	"	"	42	29	65	1.09	1.45	2.74	
5	"	"	42	26	69	.99	1.62	2.84	
6	Nov:23	"	42	29	73	.97	1.45	2.60	
7	"		44	35	73	1.08	1.26	2.47	Introspection after X_2: "Less feeling of strain in doing w than on previous two days."
8	Nov:30	"	43	32	73	1.03	1.34	2.52	
9	"	"	44	32	76	1.00	1.375	2.535	
10	"	"	45	35	80	1.00	1.29	2.415	
Experiment III.									
1	Ap:15	11 A.M.	39	28	76	.88	1.39	2.42	
2	Ap:16	10.55 A.M.	42	33	76	.99	1.27	2.38	
3	Ap:17	"	45	34	82	.96	1.32	2.42	
4	Ap:18	11 A.M.	44	34	82	.95	1.29	2.36	
5	Ap:19	11.10 A.M	44	34	81	.96	1.29	2.38	
6	Ap:20	12.40 P.M.	47	36	83	1.00	1.31	2.44	
7	Ap:22	11 A.M.	43	36	80	.99	1.19	2.265	
8	Ap:23	"	48	37	83	1.02	1.30	2.46	

Subject Q. Scores when all ws are counted as correct.

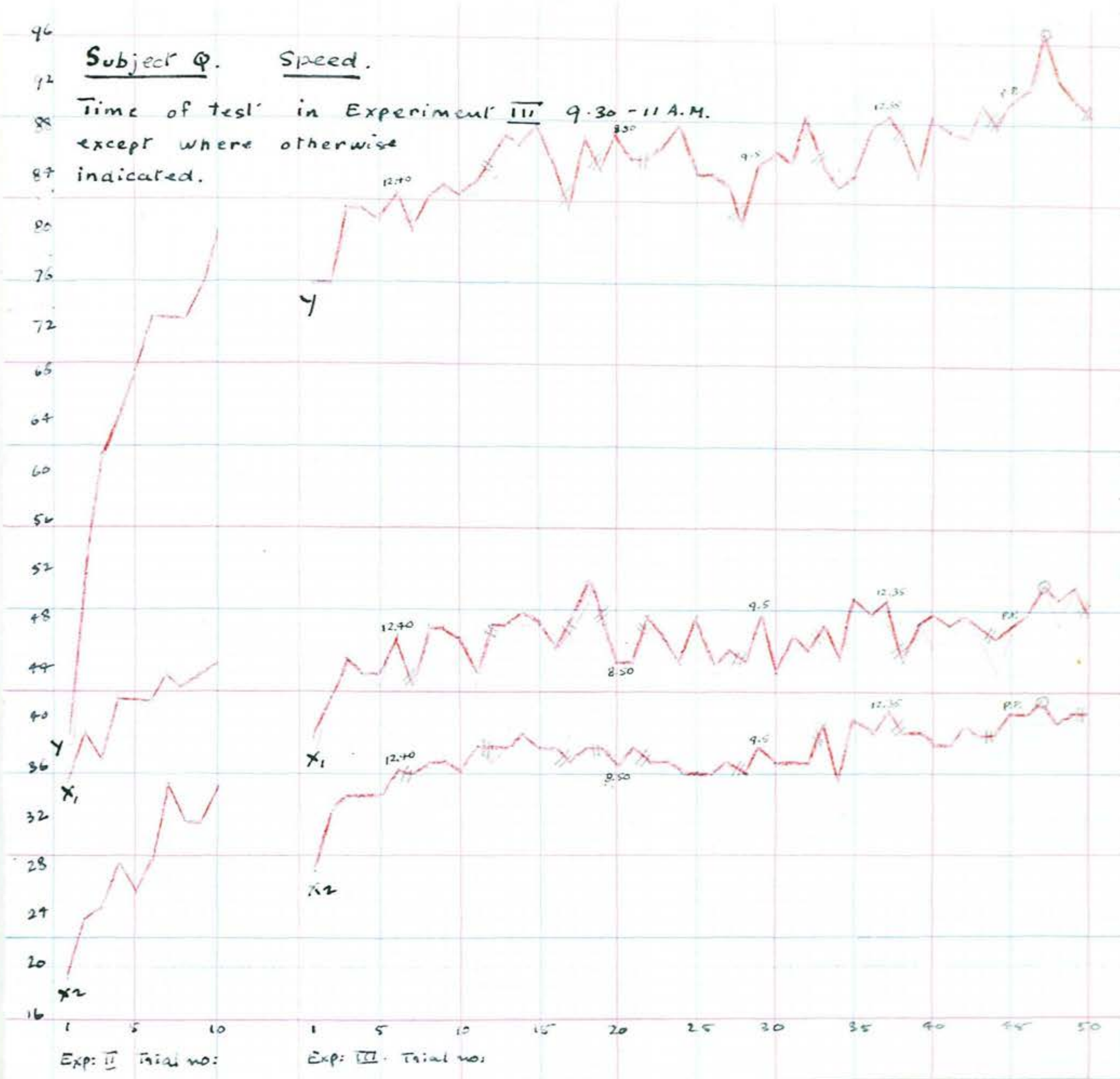
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
9	Ap:24	11 A.M.	48	37	84	1.01	1.30	2.44	
10	Ap:25	"	47	36	83	1.00	1.31	2.44	
11	Ap:26	"	44	38	84	.98	1.16	2.21	
12	Ap:29	"	48	38	86	1.00	1.26	2.38	45 seconds pause between X_1 and X_2. Noise in X_2 and Y.
13	Ap:30	10.55 A.M.	48	38	88	.98	1.26	2.35	
14	May 1	11 A.M.	49	39	87	1.01	1.26	2.39	
15	May 2	"	48	38	89	.97	1.26	2.34	
16	May 3	"	46	38	86	.98	1.21	2.28	
(17	May 6	9.40 A.M.	49	37	82	1.05	1.32	2.52)	32 seconds pause between X_1 and X_2.
18	May 7	11 A.M.	51	38	88	1.01	1.34	2.50	S. up rather late the previous night.
19	May 9	"	48	38	85	1.01	1.26	2.39	
20	May 10	8.50 A.M.	45	37	88	.93	1.22	2.24	
21	May 11	9.40 A.M.	45	38	86	.97	1.18	2.23	
22	May 13	11.5 A.M.	49	37	86	1.00	1.32	2.46	S. was in danger of being late for a lecture, and may have felt flustered.
23	May 14	11 A.M.	47	37	87	.97	1.27	2.35	
24	May 15	"	45	36	89	.91	1.25	2.26	
25	May 16	"	49	36	85	1.00	1.36	2.49	
26	May 17	"	45	36	85	.95	1.25	2.31	Noise in Y.
27	May 18	9.30 A.M.	46	37	84	.99	1.24	2.34	
28	May 20	11.30 A.M.	45	36	81	1.00	1.25	2.36	
29	May 21	9.5 A.M.	49	38	86	1.01	1.29	2.43	
30	May 22	11 A.M.	44	37	87	.93	1.19	2.20	Some ws in X_1 very wide and one thus: wr

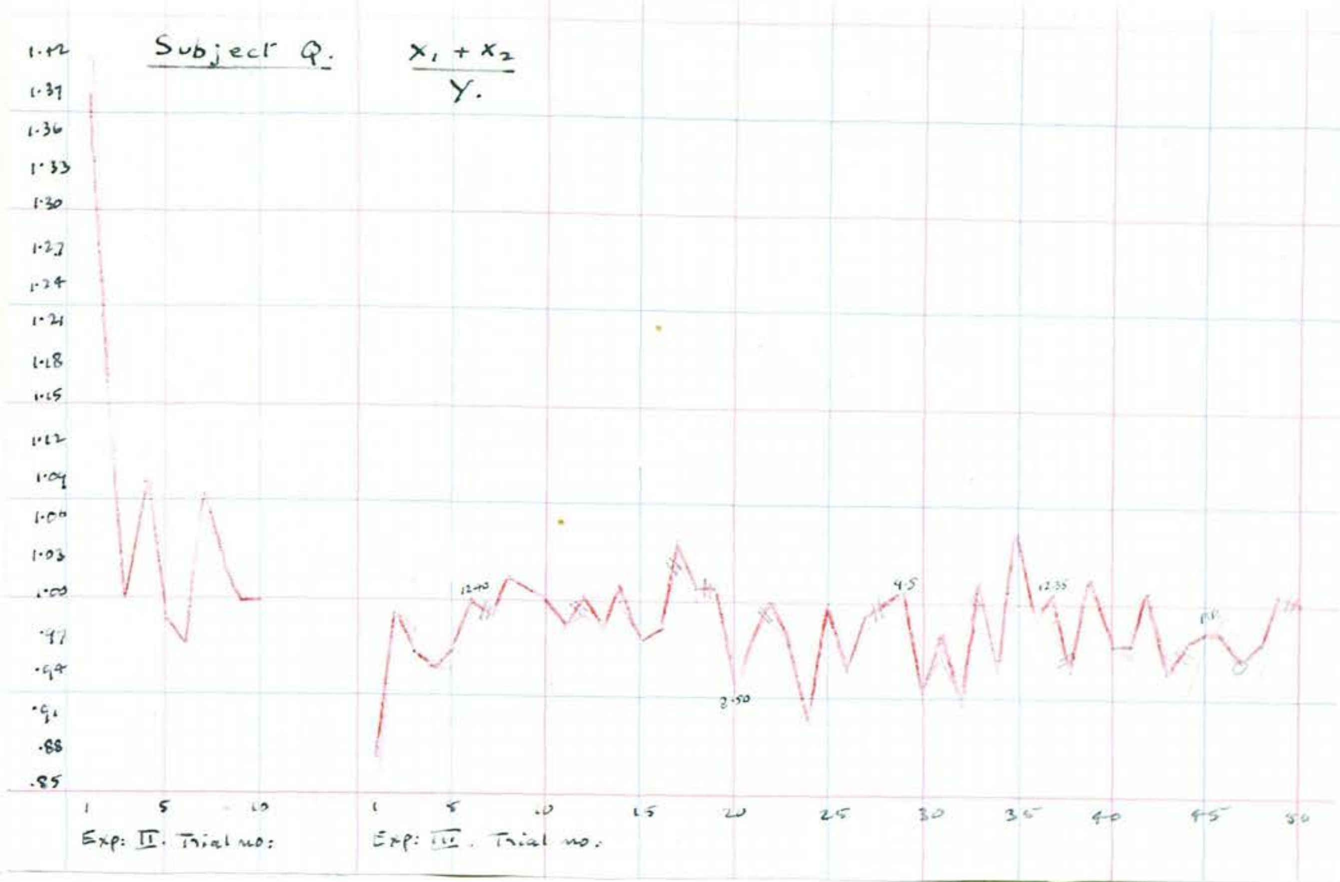
Subject Q. Score when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
31	May 23	10.55 A.M.	47	37	86	.98	1.27	2.36	Noise in X_2.
32	May 24	11 A.M.	46	37	90	.92	1.24	2.26	
33	May 28	"	48	40	86	1.02	1.20	2.32	
34	May 29	:	45	35	84	.95	1.29	2.36	
35	May 30	"	50	40	85	1.06	1.25	2.43	
36	May 31	11.15 A.M.	49	39	89	.99	1.26	2.36	
37	June 1	12.35 P.M.	50	41	90	1.01	1.22	2.33	
(38	June 3	11 A.M.	45	39	88	.95	1.15	2.17)	
39	June 4	"	48	39	85	1.02	1.23	2.36	
40	June 5	11.15 A.M.	49	38	90	.97	1.29	2.38	
41	June 6	11 A.M.	48	38	89	.97	1.26	2.34	
42	June 7	11.45 A.M.	49	40	88	1.01	1.225	2.335	Before examination.
43	June 8	10.5 A.M.	48	39	91	.96	1.23	2.28	
44	June 10	11 A.M.	47	39	89	.97	1.21	2.27	Slight noise in Y.
(45	June 11	11.15 A.M.	48	41	91	.98	1.17	2.22)	With pressure pencil.
46	June 12	11 A.M.	49	41	92	.98	1.20	2.27	
47	June 13	11.10 A.M.	51	42	97	.96	1.21	2.26	After examination. S. had been writing very fast.
48	June 14	11.5 A.M.	50	40	93	.97	1.25	2.33	After examination
49	June 15	10.20 A.M.	51	41	91	1.01	1.24	2.36	
50	June 17	11 A.M.	49	41	90	1.00	1.20	2.29	

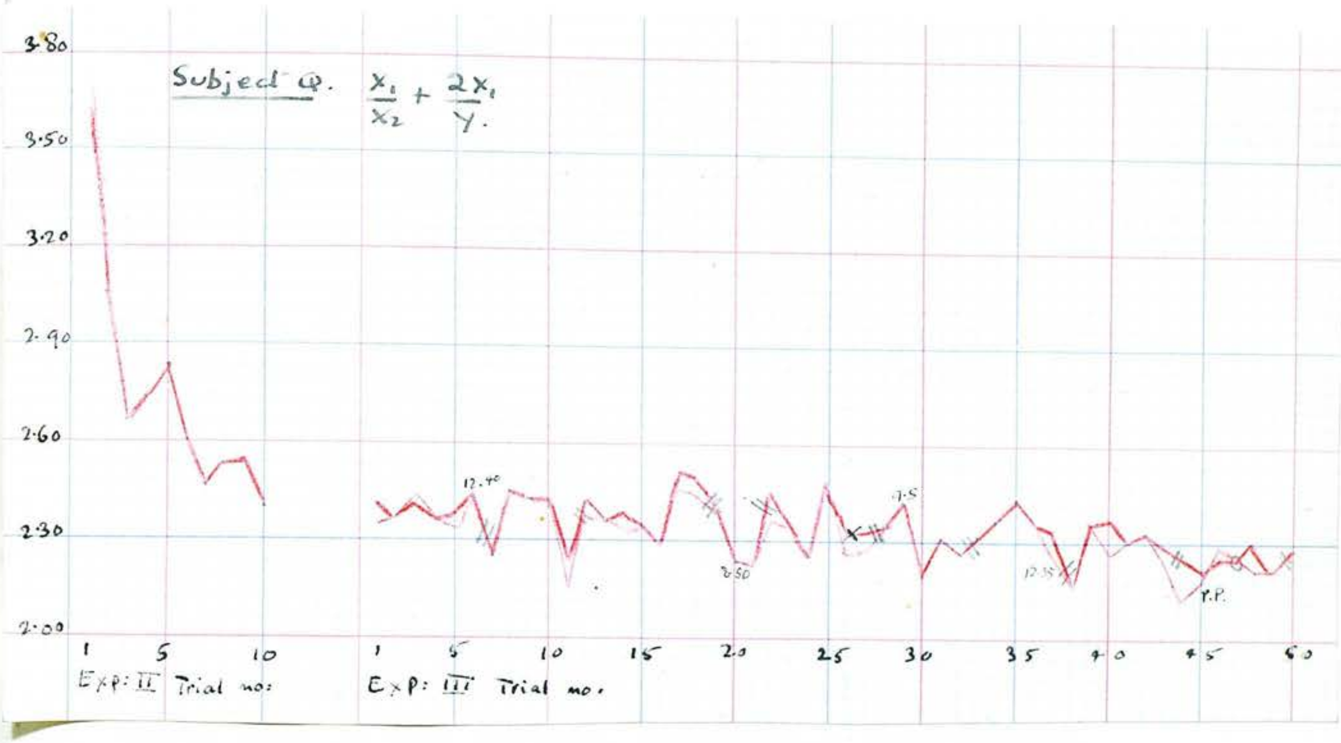
Subject Q. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
Experiment II.						
1	35	19	38 (1)	1.42	1.84	3.68
Experiment III.						
1	38 (1)	28	76	.87	1.36	2.36
3	45	34	81 (1)	.98	1.32	2.43
5	43 (1)	34	81	.95	1.26	2.32
11	43 (1)	38	83 (1)	.98	1.13	2.17
12	48	37 (1)	86	.99	1.30	2.42
14	48 (1)	39	87	1.00	1.23	2.33
17	48 (1)	37	82	1.04	1.30	2.47
18	50 (1)	38	88	1.00	1.32	2.46
22	48 (1)	37	86	.99	1.30	2.44
26	44 (1)	36	85	.94	1.22	2.26
27	45 (1)	37	84	.98	1.22	2.29
31	46 (1)	37	86	.97	1.24	2.31
32	46	37	89 (1)	.93	1.24	2.27
37	48 (2)	41	90	.99	1.17	2.24
40	46 (3)	38	87 (3)	.97	1.21	2.27
41	47 (1)	38	89	.96	1.24	2.30
43	47 (1)	39	91	.95	1.21	2.24
44	44 (3)	39	89	.93	1.13	2.12
45	47 (1)	41	91	.97	1.15	2.18
46	49	41	91 (1)	.99	1.20	2.28
47	51	42	96 (1)	.97	1.21	2.27
48	48 (2)	40	93	.95	1.20	2.23


Subject Q. Speed.
Time of test in Experiment III 9.30 - 11 A.M.
except where otherwise
indicated.
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
Y
X1
X2
12.40
8.50
9.5
12.35
1
5
10
15
20
25
30
35
40
45
50
Exp: II Trial no:
Exp: III. Trial no:


Subject Q.
x1 + x2 / Y.
Exp: II. Trial no:
Exp: III. Trial no.


Subject Q.
x1 / x2.
Exp: II. Trial no:
Exp: III. Trial no.



Subject Q. $\frac{x_1}{x_2} + \frac{2x_1}{Y}$.
3.80
3.50
3.20
2.90
2.60
2.30
2.00
1
5
10
Exp: II Trial no:
1
5
10
15
20
25
30
35
40
45
50
Exp: III Trial no.
12.40
2.50
9.5
12.35
Y.P.

Subject R. General Discussion.

Subject R is a woman, aged seventy-three. She was discarded when the general result was being considered, because the conditions of administering the test had not been kept rigid; it was impossible to keep her from talking during the test, and from practising the reversed w before beginning the X_2 part. It seems worth while, however, to give her scores, because they differ in certain ways from those of the other subjects. Instead of the usual steep fall in the scores $\frac{X1}{X_2}$ and $\frac{X_1}{X_2} + \frac{2X_1}{Y}$, at the beginning of the testing, followed by a more gradual decrease till the score reaches a level about which it fluctuates, there is, in the case of Subject R, an initial rise, followed by a moderately steep fall; the decrease becomes very gradual from about the thirtieth trial, but may not have ceased by the end. The score $\frac{X_1 + X_2}{Y}$ falls fairly steeply during the early part of the testing, fluctuating very widely, and during the later part shows less wide fluctuations about an approximately constant level.

Subject R had done one or two previous trials at the test, some months earlier, under conditions which were not very rigid, as the results were not intended for publication. The scores for her first attempt are available; the perseveration scores are 1.18/

1.18, 1.25 and 2.57 by the three methods of scoring respectively. The score 1.25 is the lowest score, by the method $\frac{X_1}{X_2}$, gained by any of the subjects in the present experiment at their first attempt at the test. This fact is out of harmony with Cattell's,[6] very tentative, finding that the perseveration score rises in extreme old age. The fact that R had high scores, when the mean score for the trials from the sixteenth to the last was taken, is of course irrelevant to Cattell's finding, as he was using the score for the first attempt at a test.

The form taken by the graphs of the perseveration scores is due partly to the fact, that the speed in X_2 does not begin to increase till the thirteenth trial, and then increases only rather gradually. This fact is in accord with Snoddy's[38] finding that very old people have low adaptability.

The fact, that the speed was low, suggests that R's motor abilities have been impaired by old age. Her other faculties are only impaired very slightly; she is a little deaf, has the presbyopia usual in the elderly, and occasionally suffers from minor failures of memory. She seemed, however, to experience some sort of mental confusion in connection with the reversed w , of which no other subject except P showed any sign. Often just before beginning the

X_2/

X_2 part, she seemed unable to remember just what she had to do. Her laughter seemed to be a kind of defensive reaction to the difficulty of the test. She also sometimes accidentally added an extra part to the reversed w , thus  . Her reversed ws were slightly tilted in a backhand direction.

Subject R. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1+X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2}+\frac{2X_1}{Y}$	Remarks.
1	Ap:15	5.25 P.M.	24	17	39	1.05	1.41	2.64	S. insisted on making about six ordinary ws as practice before X_1 and six reversed ones before X_2, and protested constantly about the difficulty of the test.
2	Ap:16	5.20 P.M.	31	22	42	1.26	1.41	2.89	S. made one practice reversed w before X_2, and spoke of the difficulty during X_2 and at the end. During Y she laughed.
3	Ap:17	5.55 P.M.	31	19	44	1.14	1.63	3.04	S. laughed in X_2 and said it was difficult.
4	Ap:18	5.55 P.M.	33	20	42	1.26	1.65	3.22	S. made two practice ws before X_2, and again laughed during X_2 and said it was difficult.
5	Ap:19	5.55 P.M.	35	21	50	1.12	1.67	3.07	
6	Ap:20	3.15 P.M.	33	20	48	1.10	1.65	3.025	S. tired. She did two practice ws before X_2 and said it was difficult.
7	Ap:21	5.20 P.M.	34	22	45	1.24	1.55	3.06	
8	Ap:22	6.15 P.M.	37	21	52	1.12	1.76	3.18	S. tired. She laughed and complained of difficulty during X_2.
9	Ap:23	5.40 P.M.	35	20	51	1.08	1.75	3.12	
10	Ap:24	6 P.M.	37	21	54	1.07	1.76	3.13	S.'s hand tired. She did a long practice before the test when E. was not there, and said that the reversed ws would be more easily written from right to left. She talked about something irrelevant in X_2

Subject R. Scores when all ws are counted as correct.

Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
11	Ap:25	5.45 P.M.	40	17	46	1.24	2.35	4.09	
12	Ap:26	5.50 P.M.	38	20	51	1.14	1.90	3.39	
13	Ap:27	4.15 P.M.	38	23	56	1.09	1.65	3.01	
14	Ap:28	6.55 P.M.	37	21	51	1.14	1.76	3.21	S. did one practice w before X_1 and talked during X_2
15	Ap:29	6.15 P.M.	40	27	56	1.20	1.48	2.91	
16	Ap:30	6.5 P.M.	39	26	62	1.05	1.50	2.76	S. felt she was slow. Her mind wandered during **Y**. She did several practice ws before X_1.
17	May 1	6.15 P.M.	39	26	56	1.16	1.50	2.89	S. did several practice ws before X_1 and X_2. She omitted to put her spectacles on for these two parts.
18	May 2	6.P.M.	38	24	65	.95	1.58	2.75	
19	May 3	7.10 P.M.	37	27	64	1.00	1.37	2.53	
20	May 4	6.25 P.M.	37	28	60	1.08	1.32	2.55	S. tired. She did the first few ws in X_2 very slowly, and went back and added an extra part to one. Towards the end of X_2 she said she thought she was adding an extra part to the ws, as she was to the last nine.
21	May 7	6.55 P.M.	39	27	60	1.10	1.44	2.74	4 minutes' pause between X_1 and X_2
22	May 8	6 P.M.	38	27	64	1.02	1.41	2.60	
23	May 9	6.55 P.M.	39	30	66	1.05	1.30	2.48	S. rather tired. She remarked on the difficulty of the reversed ws and said they looked like the figure 3.

Subject R. Scores when all ws are counted as correct.

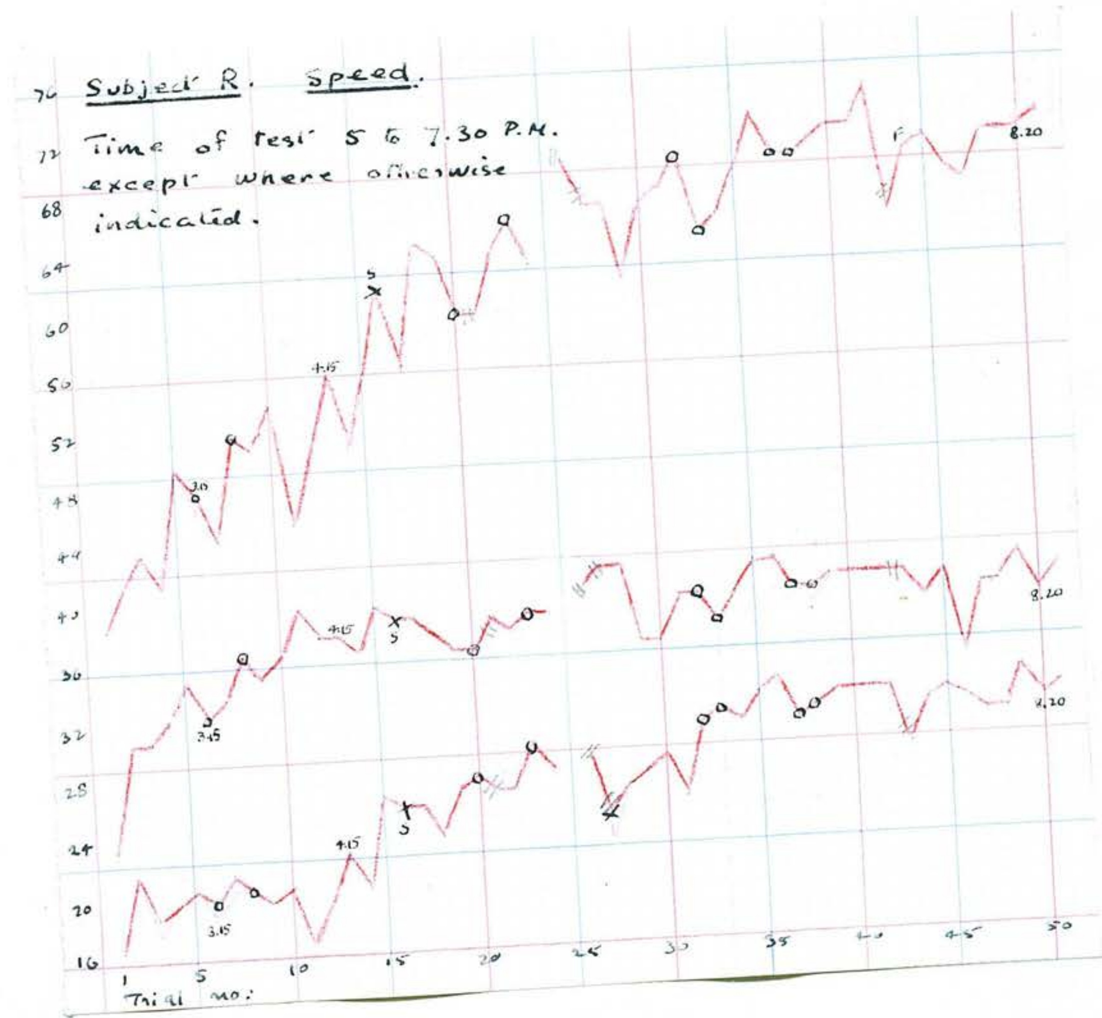
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
24	May 10	5.55 P.M	39	28	63	1.06	1.39	2.63	
25	May 11	Discarded owing to fault in procedure.							
26	May 13	6.25 P.M.	41	29	70	1.00	1.41	2.58	
(27	May 15	5.45 P.M.	42	25	67	1.00	1.68	2.93)	35 seconds' pause between X_1 and X_2 S. began to make alternating ws in X_2, possibly because her mind was wandering.
28	May 16	5.55 P.M.	42	27	67	1.03	1.56	2.81	
29	May 17	5.5 P.M.	37	28	62	1.05	1.32	2.51	
30	May 18	6.30 P.M.	37	29	67	.99	1.28	2.38	S. did two or three practice ws before X_2.
31	May 19	7.5 P.M.	40	26	68	.97	1.54	2.72	S. said X_2 was difficult.
32	May 20	6.20 P.M.	40	31	70	1.01	1.29	2.43	S. tired and had cold.
33	May 21	5.10 P.M.	38	32	65	1.08	1.19	2.36	S. tired, had cold, and had felt decidedly unwell the previous morning. A distraction occurred at the beginning of Y , about which S. talked throughout Y .
34	May 22	6.5 P.M.	40	31	66	1.08	1.29	2.50	
35	May 23	6.30 P.M.	42	33	69	1.09	1.27	2.49	S. expressed pleasure at having written more than before, but said she did not know why.
36	May 24	5.50 P.M.	42	34	73	1.04	1.24	2.39	S. talked in X_1. At the end of it, she thought she had written less, and E. suggested that this was because she had talked. She replied that the writing of ws did not require attention.

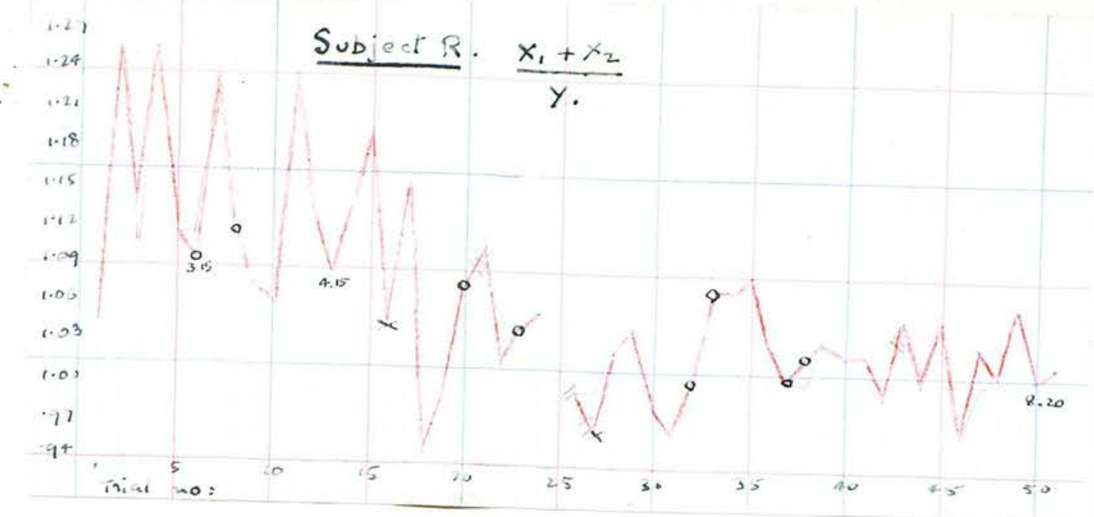
Subject R. Scores when all ws are counted as correct.

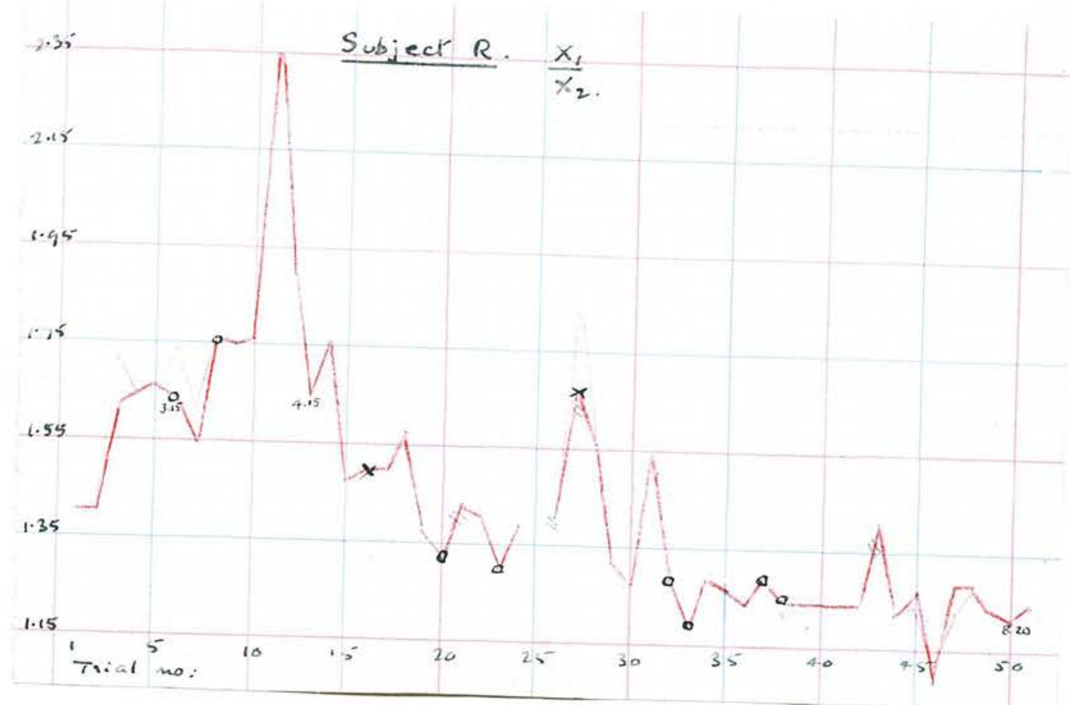
Trial No.	Date	Time	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$	Remarks.
37	May 25	7.30 P.M.	40	31	70	1.01	1.29	2.43	50 seconds' pause between X_2 and Y. S. had a cold, and coughed during Y.
38	May 26	6.35 P.M.	40	32	70	1.03	1.25	2.39	S. had a cold.
39	May 27	6.20 P.M.	41	33	71	1.04	1.24	2.39	
40	May 28	6.20 P.M.	41	33	72	1.03	1.24	2.38	
41	May 29	5.55 P.M.	41	33	72	1.03	1.24	2.38	
42	May 30	5.55 P.M.	41	33	74	1.00	1.24	2.35	
43	May 31	6 P.M.	41	29	66	1.06	1.41	2.65	45 seconds pause between X_1 and X_2. S. talked in X_1.
44	June 2	7.30 P.M.	39	32	70	1.01	1.22	2.33	S. spoke during X_1.
45	June 3	5.50 P.M.	42	33	71	1.06	1.27	2.45	
46	June 4	5.45 P.M.	35	32	69	.97	1.09	2.10	
47	June 5	5.55 P.M.	40	31	68	1.04	1.29	2.47	45 seconds' pause between X_2 and Y. S. coughed and talked during Y.
48	June 6	5.45 P.M.	40	31	71	1.00	1.29	2.42	
49	June 7	6 P.M.	42	34	71	1.07	1.24	2.42	
50	June 8	8.20 P.M.	39	32	71	1.00	1.22	2.32	
51	June 9	6 P.M.	41	33	73	1.01	1.24	2.36	

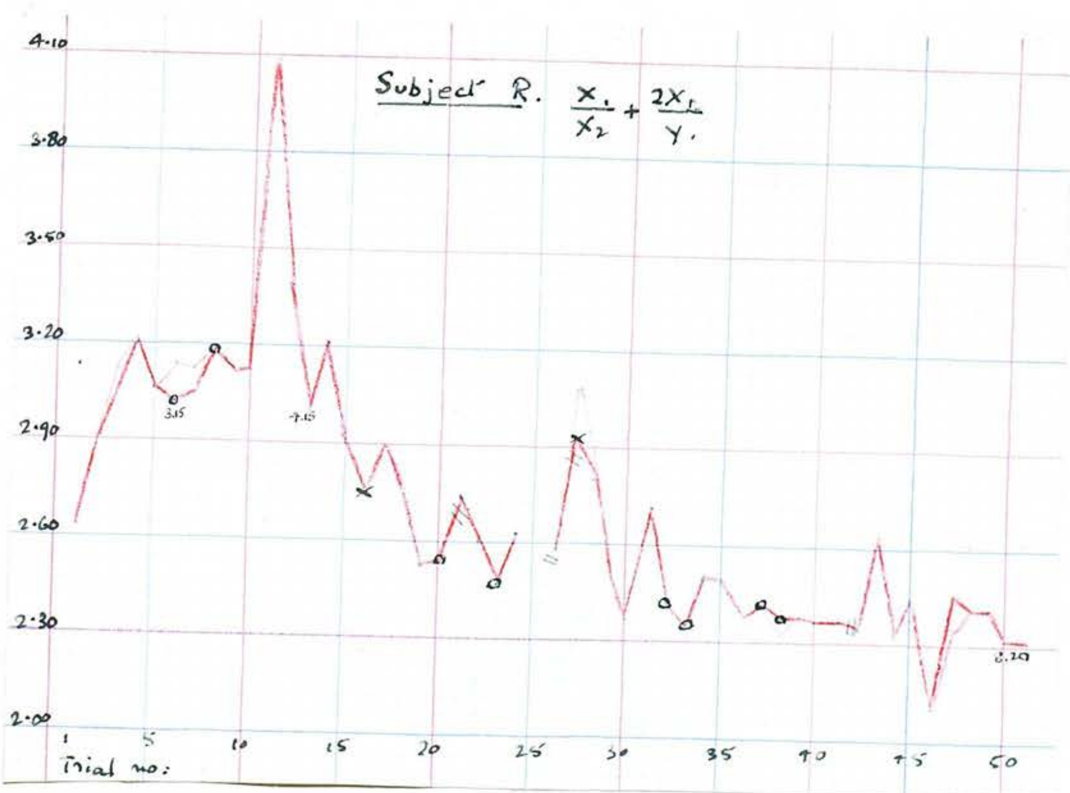
Subject R. Changes in score when imperfect ws are counted as errors.

Trial No.	X_1	X_2	Y	$\frac{X_1 + X_2}{Y}$	$\frac{X_1}{X_2}$	$\frac{X_1}{X_2} + \frac{2X_1}{Y}$
3	31	18 (1)	44	1.11	1.72	3.13
6	33	19 (1)	47 (1)	1.11	1.74	3.14
7	34	21 (1)	45	1.22	1.62	3.13
(27	42	33 (2)	67	.97	1.83	3.08)
38	39 (1)	32	70	1.01	1.22	2.33
45	41 (1)	33	71	1.04	1.24	2.39
47	38 (2)	31	68	1.01	1.23	2.35


Subject R. Speed.
Time of test 5 to 7.30 P.M. except where otherwise indicated.
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
1
5
10
15
20
25
30
35
40
45
50
Trial no:
8.20
4.15
3.15
3.0
5


Subject R. $\frac{X_1 + X_2}{Y}$.
1·27
1·24
1·21
1·18
1·15
1·12
1·09
1·06
1·03
1·00
·97
·94
3.15
4.15
8.20
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject R. $\frac{X_1}{X_2}$.
2·35
2·15
1·95
1·75
1·55
1·35
1·15
3.15
4.15
8.20
1
5
10
15
20
25
30
35
40
45
50
Trial no:


Subject R. $\frac{X_1}{X_2} + \frac{2X_1}{Y}$.
4·10
3·80
3·50
3·20
2·90
2·60
2·30
2·00
3.15
4.15
8.20
1
5
10
15
20
25
30
35
40
45
50
Trial no:

CHAPTER V. PROOF THAT THE SCORE OF AN ALTERNATION TEST IS NOT A PURE MEASURE OF DIFFICULTY IN ALTERNATING, UNLESS THE TWO UNITS CONCERNED ARE EQUALLY DIFFICULT.

It was pointed out by a student in the Ordinary Psychology Class of Edinburgh University, that, when the difference method of scoring an alternation test is used, the score is not a pure measure of difficulty in alternating, if the two items of which the test is composed are unequal in difficulty. This is true also when the ratio method of scoring is used, and is proved as follows:

If X_1 = the number of units made in the X_1 part of a test

X_2 = the number of units made in the X_2 part of a test

k = duration of the X_1 and X_2 parts, it being assumed that they are equal in length

$2k$ = duration of the Y part

Then the average time taken to make each unit in

$$x_1 = \frac{k}{X_1}$$

The average time taken to make each unit in

$$x_2 = \frac{k}{X_2}$$

Assuming/

Assuming that alternation makes the writing of the units neither harder nor easier, the average time taken to make a pair of units in Y will be

$$\frac{k}{X_1} + \frac{k}{X_2}, \text{ or } k\,\frac{(X_2 + X_1)}{X_1 X_2}$$

Then the number of pairs of units made in Y will be

$$2k \div \frac{k(X_2 + X_1)}{X_1 X_2} = \frac{2 X_1 X_2}{X_1 + X_2}$$

and the number of units made in Y will be $\frac{4 X_1 X_2}{X_1 + X_2}$.

Therefore the score $\frac{X_1 + X_2}{Y}$ may be expressed as

$$X_1 + X_2 \div \frac{4 X_1 X_2}{X_1 + X_2}$$

$$\text{or } \frac{(X_1 + X_2)^2}{4 X_1 X_2}$$

$$\text{or } \frac{X_1^2 + X_2^2}{4 X_1 X_2} + \frac{2 X_1 X_2}{4 X_1 X_2}$$

$$\text{or } \frac{X_1^2 + X_2^2}{4 X_1 X_2} + \frac{1}{2}$$

Where $X_1 = X_2$ this expression becomes 1.

Where X_1 exceeds X_2 by a, this expression becomes $\frac{(X_2 + a)^2 + X_2^2}{4 X_2 (X_2 + a)} + \frac{1}{2}$

$$\text{or } \frac{X_2^2 + 2aX_2 + a^2 + X_2^2}{4 X_2^2 + 4 a X_2} + \frac{1}{2} \text{ or } 1 + \frac{a^2}{4 X_2^2 + 4 a X_2}$$

$$\text{or } 1 + \frac{(X_1 - X_2)^2}{4 X_1 X_2}$$

A/

A corrected score, showing the true amount of difficulty experienced by the subject in alternating the units, can be obtained by subtracting $\dfrac{(X_1 - X_2)^2}{4\ X_1\ X_2}$ from the raw score $\dfrac{X_1 + X_2}{Y}$. That this correction makes only a small difference to the score, can be seen from the following examples, in which scores obtained in Experiment III are corrected:

<u>Subject B. Trial 1.</u>

$X_1 = 45$

$X_2 = 28$

$Y = 56$

$\dfrac{X_1 + X_2}{Y} = 1.30$

$\dfrac{(X_1 - X_2)^2}{4\ X_1 X_2} = \dfrac{289}{4940} = .06$

Therefore the corrected score is 1.24.

<u>Subject H. Trial 2.</u>

$X_1 = 30$

$X_2 = 21$

$Y = 64$

$\dfrac{X_1 + X_2}{Y} = .80$

$\dfrac{(X_1 - X_2)^2}{4\ X_1\ X_2} = \dfrac{81}{2520} = .03$

Therefore the corrected score is .77

Subject/

Subject B. Trial 41.

$X_1 = 53$

$X_2 = 49$

$Y = 100$

$$\frac{X_1 + X_2}{Y} = 1.02$$

$$\frac{(X_1 - X_2)^2}{4\, X_1\, X_2} = \frac{16}{10388} = .002$$

Therefore the corrected score is still 1.02.

Subject A. Trial 20.

$X_1 = 52$

$X_2 = 34$

$Y = 84$

$$\frac{X_1 + X_2}{Y} = 1.02$$

$$\frac{(X_1 - X_2)^2}{4\, X_1\, X_2} = \frac{324}{7072} = .05$$

Therefore the corrected score is .97.

The last example shows, that a score larger than unity may become smaller than unity as a result of correction.

In spite of the comparative smallness of the effect of correcting the score, the fact remains that there is bound to be a small positive correlation, for mathematical/

mathematical reasons alone, between any creative effort test, and any alternation test, in which the items are unequal in difficulty, provided that the score in the creative effort test, and the degree of difficulty experienced in performing the harder kind of item in the alternation test, are determined by the same factor. In other words, a correlation between a creative effort test and an alternation test may be due solely to the factor or factors, which determine the performance in creative effort tests. It is tempting to suggest, that all the correlations between perseveration tests may be due to the degree of difficulty, experienced by the subject in performing a new manual movement, but this cannot be proved. If it were true, one would expect the greatest number of statistically significant correlations to be between creative effort tests, but this is not so. Twelve statistically significant correlations, excluding the spuriously high one found by Cattell,[6] have been obtained between pairs of motor perseveration tests by those investigators, who have either used the "ratio method" of scoring, or have used the "difference method" but have eliminated speed. Of these correlations, three are between two creative effort tests, five are between two alternation tests, and four are between a creative effort test and an alternation test. On the other hand, four out of the five alternation/

alternation tests, involved in these correlations, namely the Reverse Stroke (alternating) Test, the $\infty \neq$ Test, the Perseverameter, and the S Test, involve the making of unfamiliar movements. The fifth, however, namely the Alphabets Test, does not, unless the mere writing of the capital letters A B C D in order be regarded as an unfamiliar movement. The question must therefore be left unsettled. It would, however, be interesting to know, whether the correlations involving alternation tests would become insignificant, if the scores were corrected for the effect of the unequality in difficulty of the two kinds of unit used in the test.

CHAPTER VI. TWO SUBSIDIARY EXPERIMENTS DEALING WITH SPONTANEOUS IMAGERY.

i. Introduction.

Two experiments dealing with spontaneous imagery have been done; a questionnaire was given to the subjects of Experiment II, and a diary was kept by the writer, in which she recorded her own spontaneous imagery. They must be regarded as minor, subsidiary experiments, because no conclusions have been established, but the results are interesting and suggest a problem for future research. The questionnaire was given, in the hope that the results would suggest problems, which could be pursued further by means of a questionnaire given to a larger group of Subjects, but the writer subsequently came to the conclusion, that, as there is a possibility that spontaneous imagery is caused by unconscious motivation, questionnaires are too superficial a method by which to study it. The diary was kept mainly for the purpose of trying out a less superficial method of study.

The results obtained by previous investigators suggest, that nothing of value is likely to be achieved by giving subjects a numerical score, corresponding with the amount of spontaneous imagery, which they/

they say they have in their replies to a questionnaire, and then correlating this with their scores for motor tests of perseveration. This was the procedure followed by Lankes[24], and he did not obtain any significant correlations between the score for the questionnaire and that for any motor test. While he did obtain significant correlations between spontaneous imagery and certain ideational tests, to accept these as proof of the existence of the "perseverative tendency", without study of the processes involved, is to take a superficial attitude. The only other investigator who used a questionnaire on imagery was Cattell[5], and he found only a very slight tendency, which may not be significant, for those with high scores in motor tests to have more spontaneous imagery than those with low scores. Much more study of the precise conditions of the occurrence of spontaneous imagery is needed, before further quantitative work is done.

ii. Questionnaire given to the subjects of Experiment II.

a. Procedure.

The questionnaire was read out to the subjects, question by question, on the last day of Experiment II, and answers were written by them on their test papers/

papers. It was adapted from that of Lankes[24], and was as follows:

1. If you have been for a journey in a train or a steamer or a bus, do you feel the movement in your body afterwards?
2. Do you ever have a tune running in your mind?
3. If so, how often? - for example, is it every day, about twice a week, about once a week, or very occasionally?
4. Does it happen more often under any special conditions, for example, with a tune you specially like or dislike, one you have heard for the first time, or one you have heard very often?
5. Do you usually sing it, or just have auditory imagery of it?
6. Do words or phrases ever run in your mind?
7. About how often?
8. Does it happen more often under any special conditions?
9. Do you ever have spontaneous visual imagery? This does not mean imagery connected with what you are thinking about or remembering, but imagery which appears of its own accord.
(The wording of this explanation was varied a little on different days.)

10./

10. About how often?
11. Does it happen more often under any special conditions.
12. Are you ever late for things as a result of getting interested in something else and forgetting the time?

Twenty-five of the Wednesday and Friday Group and nineteen of the Monday Group, were present on the days on which the questionnaire was given, making forty-four in all.

b. Results.

The first fact, which appears when one looks at the results, is that auditory imagery recurs spontaneously much oftener than other kinds. Every subject without exception experienced some recurrence of tunes, and only three experienced no recurrence of words and phrases, while ten had no spontaneous visual imagery, and twelve had never felt the movement of a vehicle in their bodies after a journey. One wonders whether the spontaneous recurrence of auditory imagery, and of the impulse to sing tunes, is some relic of the impulse, which the small child must have, to vocalise what he hears.

The main interest of the present results lies in the reasons given for the spontaneous recurrence of imagery. Reasons were, of course, suggested in the/

the questionnaire, but it is hard to believe that the replies are entirely due to the suggestion contained in the questions. It seems improbable, in view of some of the replies given, that the amount of spontaneous imagery which an individual has, is simply a function of the strength in him of a general tendency towards spontaneous imagery. It is much more likely, that the amount of such imagery varies from time to time in the same individual, according to the presence or absence of conditions which favour it.

One condition, which seems to favour the spontaneous occurrence of imagery, is the individual's interest in, or liking for, the subject-matter of the image. One student, who is taking an honours degree in Celtic, replied that he has the same pipe-tune constantly in his mind, that Gaelic phrases recur, and that the visual image of a great Celtic poet appears very frequently. Clearly his spontaneous imagery is the expression of a dominant interest. Another student has spontaneous visual images of her parents and friends, especially after receiving letters from them. Another said that the tunes which recur are those which she likes, and which she first heard on some exciting occasion. A large number said that the tunes which recur are those which they like, though others replied, that tunes which are liked and disliked recur with/

with equal readiness. A student, who intends to go into the Church, replied that auditory images of good texts recur spontaneously. In the case of auditory images of words and phrases, it seems, however to be generally vividness or unusualness, rather than pleasantness, that favours recurrence, though one student spoke of "pleasing place-names" as recurring. One said that "uncommon, witty or ungrammatical" phrases recur. Several spoke of "striking" or "apt" phrases as recurring, and one or two of phrases in foreign languages.

Another condition, which seems to favour recurrence, is the fact that the subject-matter is unfamiliar, or is in process of being learnt. This result is in accordance with Muller's[27] finding, that there was the greatest amount of spontaneous recurrence of syllables on the first day of the experiment. The following replies may be given as examples:

"A tune I have heard for the first time frequently recurs, especially if it is an elusive one which I find difficultyin remembering."

"A new word or phrase is apt to run in my mind."

"If I have heard a catching melody or have been learning one, it may occur at frequent intervals. The occurrence may be once or twice a day till I feel familiar with it."

"It occurs . . . . . also often with a new tune of which I do not feel quite certain."

"If/

"If I am not sure of the tune I go about singing it, trying to remember how it goes and am not satisfied till I get it."

There is however considerable difference between individuals as to whether the tunes that recur are new or familiar ones.

Recent experience of the tune or phrase or of the subject-matter of the visual image was often given as a condition favouring recurrence.

A few subjects mentioned particular physical conditions and times of day as favourable to spontaneous recurrence. Here again there was considerable difference between individuals. For example, one said that visual images come when she is tired and sleepy, another that tunes occur when she is depressed, and another that the occurrence of tunes is favoured by good health and freedom from work. It will be remembered that Muller[27] had spontaneous imagery when falling asleep and waking.

An approximate indication of the frequency, with which different conditions favouring recurrence were mentioned, may be given by means of the table which follows. It can be only approximate, owing to the difficulty of classifying some of the replies.

Condition favouring recurrence.	Number of times it is mentioned. Tunes	Words and Phrases	Visual Imagery
Pleasantness	23	3	2
Vividness	3	9	1
Unfamiliarity	11	0	0
Fact that the subject-matter is being learnt.	7	6	0
Recency	14	3	0
Recent experience of something associated.	1	2	1
Pleasant or interesting associations.	2	1	0
Frequency, familiarity	18	1	0
When mind is vacant	1	2	6
When writing (letter, essay, examination)	0	2	0
When doing task, studying	0	1	1
Poor health, fatigue	2	0	1
Good health	1	0	0
Depression, worry	0	1	1
Freedom from work	3	0	0
In morning	0	1	0
In evening	0	0	1
In bed	0	2	1
No conditions known	0	4	1
Question misunderstood	0	2	2

The question about feeling the motion of the vehicle after a journey produced the information, that the degree, to which motion is felt, varies according to the kind of vehicle and the length of the journey, as well as from one individual to another. In general, it is felt more in the case of long journeys and unusual vehicle. The question about unpunctuality produced nothing of interest.

iii. Account of a record kept by the writer of her own spontaneous imagery.

a. Problem and Procedure.

Three main causes for the appearance of spontaneous imagery were suggested by the students' replies to the questionnaire, namely, the fact that the subject-matter has been recently experienced, the fact that it is pleasant or interesting, and the fact that it is unfamiliar or is being learnt. A fourth possible cause is that of unconscious motivation. Indications of this could not be expected from replies to a questionnaire, and it is possible that some of the replies given were rationalisations. In order to try out a more thorough method of investigating the part played by these four causes in the determination of spontaneous imagery, the writer recorded her own spontaneous imagery in a diary, for a period of six weeks.

As/

As a rule, one or two entries were made in the morning, one in the early afternoon, and one or two in the late afternoon or evening. In addition, a fair proportion of the spontaneous imagery, which occurred in the night, was recorded directly it occurred. It proved impossible to record it all without losing too much sleep. For the first three weeks, no attempt was made to influence the content of the imagery; if the writer found herself singing a tune, she either continued, or stopped singing altogether, but never substituted another for it, even on one or two occasions, on which there was a desire to do so. At the beginning of the fourth week, she asked a friend to choose eight tunes, and sang one of these deliberately on each of the next eight mornings, in order to see if it would recur spontaneously later in the day. Three verses were sung in each case. On the next eight days, the same eight tunes were sung, one each morning, for a much longer period. Finally, one of these was chosen, which was not specially liked or disliked, and was sung on a number of occasions during the next five days, to see if it would occur spontaneously in the interval.

b. Results.

Of the tunes which were sung deliberately, the majority recurred spontaneously once, shortly after they/

they had been sung, but no more. Only one recurred later in the day, and this was one which had occurred spontaneously during the earlier part of the experiment. The result was the same both when only three verses were sung, and when the tune was sung for a longer time. The tune, which was sung frequently during the last five days, occurred spontaneously, on several occasions, within two hours of being sung deliberately, but never recurred really persistently. Throughout the last three weeks of the record, a large number of tunes occurred spontaneously, which had not been sung deliberately. Thus it seems that there are some individuals, at any rate, in whom recent experience of a tune is only a minor factor in causing its recurrence.

Apart from the tunes which were sung deliberately, ninety-five occurred during the period, in addition to at least seven which were forgotten before they could be recorded. Seventy-eight were, in a greater or less degree, liked, but as the writer finds far more tunes in general pleasant, than unpleasant or neutral, it is possible, that the pleasantness of a tune is not really the cause of its recurrence. The same may be true of the students. The feeling tone of the words and phrases was, of course, determined mainly by their associations. Ten had pleasant associations, twelve had unpleasant ones, and forty-nine/

forty-nine had neither to any degree. Of one hundred and fifty-four spontaneous visual images, forty-one were of plants and flowers and were somewhat pleasant, and ten others might also be regarded as mildly pleasant, or as having pleasant associations, but the majority were neutral in feeling tone. Three, however, were clearly the expression of an impulse connected with an emotional attitude.

Some evidence can be obtained from the record in favour of the view, that material recurs, which is in process of becoming familiar. Thirty-two of the tunes which occurred were difficult to remember or to sing correctly. A large number of the words or phrases were uncommon - ten were in foreign languages, twenty-four were proper names, and thirteen were uncommon English words and phrases, including technical terms, dialect phrases and a trade name. Seven of the proper names were names of places in Skye, an island with which the writer was previously unfamiliar, and in which she was planning a holiday. The visual imagery of plants and flowers was largely set going by country walks, which are not an every-day experience, and eleven of the visual images were of more or less unfamiliar apparatus, with which the writer had been dealing.

The hypothesis, that spontaneous imagery is due to unconscious motivation, can be dealt with only superficially/

superficially. The only evidence that supports it, in the case of the tunes, is that a tune once occurred in the night directly the writer woke from a dream, but there is more evidence for it, in the case of the words and phrases and the visual imagery. Five of the words and phrases were associated with incidents in dreams, and three with early childhood incidents. Four seemed to be associated with intimate bodily functions. This is not a very large proportion, but it may be large for so superficial a study, in which only the most immediate associations were noted. Also a number of the words and phrases were nonsensical, and could never have been heard in the form in which they occurred, which shows that some mental process, other than mere memory, was at work in causing their appearance. Of the visual images, four were of early childhood scenes, or of objects associated with early experiences, and seven were either associated with dream incidents, or were actually reproductions of parts of dreams. At least twenty seemed to bear some general resemblance to dreams in their subject-matter, but, as nineteen of these occurred in the night, the conditions producing them may have been different, from those which operate in the day-time.

It is possible that both unconscious motivation, and the need of the mind to work over the unfamiliar, may contribute to the causation of the spontaneous occurrence/

occurrence of imagery. That both may contribute to the causation of the same image, is suggested by the following example: The word "Westbarns" occurred spontaneously. An hour or two previously the writer had seen the unfamiliar Swedish word "skolbarns". She wondered why this should have become changed to "Westbarns", and presently she became dimly aware, that Westbarns might be the name of a place near Dunbar, where she spent a holiday at the age of four. She asked someone if this was so, and was told that it was. The question of the cause of spontaneous imagery might be settled if a diary of the kind just described were kept by, say, six trained psychologists who, as a result of being psychoanalysed had gained an understanding of the causation of dreams, and if they then attempted to interpret a fair proportion of their own spontaneous imagery, by associating freely to it at length. The diary itself need be shown to nobody; the results could be sent to the organiser of the experiment, in the form of answers to a questionnaire.

CHAPTER VII. SUBSIDIARY EXPERIMENT: THE TAKING OF POINT PRESSURE RECORDS FROM SOME OF THE SUBJECTS OF EXPERIMENT III.

i. Introduction.

The experiment, of which an account is to be given in this chapter, deals with a minor problem unconnected with the rest of this investigation. It is included mainly because it is an example of a form, which further study of motor tests in the future might take, namely the detailed analysis of the movements involved. The apparatus used in this experiment was relatively crude, and yet revealed a fact concerning the w Test, that would have been hard to discover by other means. A finer method of analysing the writing-movements, as, for example, the taking of a cinematograph record, might reveal much more, and might make it possible to say just where the difficulty in performing a motor test lies.

ii. Problem.

A fair number of subjects actually do the alternation part of a test, which consists of "long" units, faster than the other two parts; that is to say, their score for the Division Signs Test, or for the w Test, when the scoring $\frac{X_1 + X_2}{Y}$ is used, is less than unity/

unity. Three possible explanations of this phenomenon suggested themselves. In the first place, facility in doing the alternation part of a test might result from the subject's perceiving the pairs of items as units. This view is held by some psychologists, and some evidence, which cannot however be regarded as conclusive, has been given in favour of it, in the account of Experiment II. A second explanation might be, that the change of activity enables some sort of recuperation to take place in the parts of the neuro-muscular system involved. A third might be, that the items in the alternating part, even if not perceived by the subject as a unit, are done in pairs by some subjects, in the sense that the pause following the reversed w is longer than the pause following the ordinary one, and that recuperation takes place in this longer pause. If such recuperation does take place, it might cause the total speed of the Y part to be greater than that of the X_1 and X_2 parts, in any or all of three ways. It might enable the actual ws to be written faster, or it might enable the pause following the ordinary w to be so much shortened, that the total time occupied by pauses in the Y part should be less than in the other parts of the test, or it might cause the number of "blocks" in the Y part to be less than in the other parts. "Blocks" are presumably due to fatigue. It was de-cided/

decided to take records of the writing pressure in the w Test, from some of the subjects in Experiment III, in order to find, whether the pauses following the reversed ws in the Y part were actually longer, than those following the ordinary ones, in the case of those subjects whose score for the trial concerned was less than unity.

iii. Procedure.

The apparatus used was the point pressure cheirograph, or pressure pencil, invented by Professor Drever, and described in his paper, published in the Proceedings of the Royal Society of Edinburgh for 1913-14. It is a pneumatic pencil, that records the heaviness of the pressure on the pencil point. It also, of course, records whether the pencil is touching the paper at all or not, and thus enables the duration of the ws and the pauses between them to be measured. A quickly responding tambour and a lightly smoked drum were used. It proved extremely difficult to keep the pointer at the right pressure; when it pressed too heavily on the smoked paper it did not fall right to the base line in the pauses, and so did not record accurately, and in the attempt to keep the pressure light, parts of the records were missed completely. This source of error could have been eliminated by taking repeated records from each subject till a

satisfactory/

satisfactory one was obtained, but it seemed undesirable to take more than one from each, as this would have spoilt the result of Experiment III, which was much more important. Actually, practically perfect records were obtained from Subjects J and Q, and records sufficiently satisfactory to be used, from Subjects A, B, K, L, M, N and O. A practically perfect one was also obtained from Subject I, but was discarded because his way of writing ws was so different from that of any other subject. The test was done as nearly as possible under the usual conditions, but several of the subjects felt disturbed by the unfamiliarity of the pencil, and so may not have behaved as they usually do when performing the test. This is a source of error which is very hard to eliminate. The record was, however, taken from one of the latest trials, so that the activities should be as well established as possible. As the drum rotated in about forty seconds, it was usually possible to record the whole of the X_1 and X_2 parts, and about two-thirds of the Y part; sometimes the very end of the Y part was recorded as well.

iv. Results.

The length on the records of the ws and the spaces between them was measured, by means of dividers and a diagonal scale, to the nearest .01 of an inch. To/

To measure them all would have been too laborious, so it was decided to measure ten ws and spaces at or near the beginning and end of each of the X_1 and X_2 parts, and ten of each kind of w and of the spaces after each kind of w, at or near the beginning and end of the Y part, and to find the mean of each of these sets of ten measurements. Actually it was only possible to make all the desired measurements on the records obtained from Subjects J and Q; on the records of the other seven subjects as many as possible of the measurements were made.

To find the probable errors of all these means would also have been too laborious, so the probable errors were found of the four means, which were derived from measurements having the longest ranges. These were as follows:

For the mean of the 10 ws near the end of X_2, in the case of Subject K, which are derived from measurements having a range of .16, P.E. = .0134.

For the mean of the 10 reversed ws near the end of Y, in the case of Subject N, which were derived from measurements having a range of .14, P.E. = .0095.

For the mean of the 10 ws near the end of X_1, in the case of Subject M, which are derived from measurements having a range of .12, P.E. = .0079.

For the mean of the 9 reversed ws in Y, in the/

the case of Subject M, which are derived from measurements having a range of .10, P.E. = .0070. The products of multiplying these probable errors by four are .0536, .0380, .0316, and .0280 respectively. Therefore, except where one of the first two of the above means is involved, the difference between any two means in the results which follow will be regarded as statistically significant, if it is .03 or over. Actually, many differences of less than .03 are probably significant, both because the range of the measurements from which they are derived is in many cases small, and because the ws and pauses, which have been measured are a rather large sample of the total number made. Sufficient conclusions can, however, be drawn, by regarding only differences of .03 or over as significant; if smaller differences are also considered, the results are essentially the same.

The mean and range of the lengths of the ws and pauses, made by Subjects A, B, J, K, L, M, N, O and Q, will now be given. As it is the length on the record, and not the actual time taken in making the w or in pausing, that has been measured, and as the drum did not rotate at the same speed in the case of all the subjects, the results of different subjects are not comparable with each other. It is only the lengths on the record of the ws and pauses, made in different parts of the test by the same subject, that can be compared.

Subject A.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.02*

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .96

Part of test concerned	Mean length in inches	Range of lengths in inches
10 ws near beginning of X_1	.24	.23 - .26
" " at end " "	.25	.24 - .26
10 pauses near beginning of X_1	.06	.06 - .07
" " at end " "	.05	.05 - .06
10 ws near beginning of X_2	.30	.27 - .33
" " at end " "	.27	.24 - .29
10 pauses near beginning of X_2	.12	.09 - .17
" " at end " "	.08	.07 - .09
10 ord: ws near beginning of Y	.23	.22 - .23
9 " " at end " "	.21	.19 - .22
10 pauses after ord: ws near beginning of Y	.06	.05 - .07
9 pauses after ord: ws at end of Y	.06	.06 - .07
10 rev: ws near beginning of Y	.27	.25 - .27
" " " at end " "	.24	.23 - .26
10 pauses after rev: ws near beginning of Y	.075	.07 - .09
10 pauses after rev: ws at end of Y	.065	.06 - .07

* In all cases, the score given will be that obtained when all ws are counted as correct.

In the case of Subject A, the pauses after the reversed ws in Y show some tendency to be longer than those after the ordinary ones, but the difference is probably not significant. There is an acceleration in speed in the course of X_2 and Y; in Y it affects only the reversed ws to a significant degree. Both the reversed ws and the pauses after them are significantly shorter in Y than in X_2, if the beginning be compared with the beginning, and the end with the end, and the ordinary ws are significantly shorter at the end of Y than at the end of X_1.

Subject B.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.00

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .98)

Part of test concerned.	Mean length in inches.	Range of lengths in inches.
20 ws in various parts of X_1	.245	.22 - .28
20 pauses " " " "	.05	.03 - .10
10 ws near beginning and in middle of X_2	.26	.25 - .28
10 ws at end of X_2	.26	.25 - .27
10 pauses near beginning and in middle of X_2	.055	.05 - .07
10 pauses at end of X_2	.07	.05 - .08
10 ordinary ws in first half of Y	.23	.22 - .24
9 ordinary ws in second half of Y	.22	.21 - .23
10 pauses after ordinary ws in first half of Y	.05	.04 - .06
10 pauses after ordinary ws in second half of Y	.05	.04 - .06
10 reversed ws in first half of Y	.245	.24 - .25
10 " " " second half of Y.	.25	.23 - .26
10 pauses after reversed ws in first half of Y	.06	.04 - .08
10 pauses after reversed ws in second half of Y	.05	.04 - .06

Here the pauses after the reversed ws in Y are practically the same length as those after the ordinary ones. There is no increase in speed in the course of X_2 and Y , as there was in the case of Subject A. The reason, why the score $\frac{X_1 + X_2}{Y}$ is less than unity, appears to be that both sorts of w have been written slightly faster in Y than in X_1 and X_2, and that the pauses at the end of X_2 are slightly longer than any in Y. None of these differences is statistically significant, but in combination they seem to have been sufficient to reduce the score to .98. The ws measured are, of course, a rather large sample of the total number made.

Subject J.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.00

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .97).

Part of test concerned.	Mean length in inches.	Range of length in inches.
10 ws near beginning of X_1	.23	.22 - .24
" " at end " "	.22	.21 - .26
10 pauses near beginning of X_1	.07	.06 - .09
" " at end " "	.07	.07 - .09
10 ws at beginning of X_2	.26	.24 - .27
" " at end " "	.26	.23 - .31
10 pauses at beginning of X_2	.09	.07 - .10
" " at end " "	.07	.06 - .07
10 ord: ws at beginning of Y	.22	.21 - .24
" " " at end " "	.19	.17 - .22
10 pauses after ordinary ws at beginning of Y	.085	.07 - .12
10 pauses after ordinary ws at end of Y	.07	.06 - .08
10 rev: ws at beginning of Y	.24	.22 - .25
" " " at end " "	.21	.18 - .24
10 pauses after reversed ws at beginning of Y	.07	.05 - .09
10 pauses after reversed ws in middle and at end of Y	.06	.05 - .08

Here the pauses after the reversed ws in Y are, if anything, slightly shorter than those after the ordinary ones. Both sorts of w have been written significantly faster at the end of Y than they have at the beginning, and also than they have in X_1 and X_2. The score would probably not have been less than unity, if the Y activity had been stopped at the end of thirty seconds, and the number of alternating ws made in that time doubled.

Subject K.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.08

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .97).

Part of test concerned	Mean length in inches.	Range of lengths in inches.
10 ws at beginning of X_2	.295	.28 - .32
10 ws in middle and at end of X_2	.34	.28 - .50
10 pauses at beginning of X_2	.09	.07 - .15
10 pauses in middle and at end of X_2	.09	.07 - .11
10 ordinary ws near beginning of Y	.265	.24 - .28
10 ordinary ws at end of Y	.26	.25 - .28
10 pauses after ordinary ws at beginning of Y	.07	.05 - .09
10 pauses after ordinary ws at end of Y	.05	.03* - .06
10 reversed ws at beginning of Y	.33	.30 - .34
" " " at end " "	.305	.27 - .33
10 pauses after reversed ws at beginning of Y	.08	.06 - .10
10 pauses after reversed ws at end of Y	.06	.06 - .08

* An approximation, as lengths of less than .04 inches cannot be measured accurately. The next shortest is .05.

The ws and pauses in X_1 could not be measured accurately, because Subject K sometimes scarcely lifted his pencil from the paper between the ws , so that the pointer did not fall right to the base line. A "pause" measuring 0 inches might have been counted on each of these occasions, but to do so seemed rather arbitrary. There were also some very short pauses, less than .04 inches in length, which could not be measured really accurately.

The pauses after the reversed ws at the beginning of Y are significantly longer than those after the ordinary ws at the end, but if those in the same part of Y are compared with one another, the difference is not significant, though it is in the same direction. Thus there is some evidence, in the case of Subject K, for the presence of a rhythm involving a relatively long pause after each pair of ws , but it is not conclusive. It is impossible, without the presence of measurements of the X_1 part, to tell exactly why the score $\frac{X_1 + X_2}{Y}$ is less than unity, but it is clear that part of the cause is that the pauses at the end of X_2 are significantly longer than those at the end of Y.

Subject L.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = .97

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .98).

Part of test concerned.	Mean length in inches.	Range of lengths in inches.
10 ws near beginning of X_1	.28	.27 - .30
" " near end " "	.28	.25 - .33
10 pauses near beginning of X_1	.11*	.08 - .14
" " near end " "	.09	.06 - .11
10 ws near beginning of X_2	.32	.29 - .33
" " near end " "	.305	.28 - .33
10 pauses at beginning of X_2	.18	.15 - .24
" " near end " "	.14	.12 - .15
10 ordinary ws near beginning and in middle of Y	.29	.27 - .32
10 ordinary ws at end of Y	.27	.25 - .31
10 pauses after ordinary ws near beginning and in middle of Y	.10	.08 - .13
10 pauses after ordinary ws at end of Y	.08	.06 - .11
10 reversed ws near beginning and in middle of Y	.32	.29 - .34
10 rev; ws at end of Y	.27	.25 - .28
10 pauses after reversed ws near beginning and in middle of Y	.12	.09 - .16
9 pauses after rev: ws at end of Y	.09	.08 - .10

* If two "blocks", measuring .19 and .25 inches respectively, be included in this average, it becomes .125.

Here, for the first time, the pauses after the reversed ws in Y are significantly longer than those after the ordinary ones, at least at the end. The reason why the score is less than unity appears to be because the pauses in X_2 are much longer than in Y', and because the reversed ws have been written significantly faster at the end of Y, than in X_2. There is a significant shortening of the pauses in the course of X_2, and of both the reversed ws, and the pauses after them, in the course of Y.

Subject M.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.08

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = 1.20)

Part of test concerned.	Mean length in inches	Range of lengths in inches
10 ws near beginning of X_1	.265	.24 - .30
" " near end " "	.30	.26 - .38
10 pauses near beginning of X_1	.07	.06 - .09
" " near end " "	.07	.05 - .11
10 ws at beginning of X_2	.30	.28 - .33
" " near end " "	.29	.26 - .33
10 pauses at beginning of X_2	.11	.07 - .13
" " near end " "	.13	.10 - .17
10 ordinary ws in various parts of Y	.255	.20 - .29
7 pauses after ordinary ws in various parts of Y	.08	.06 - .13
9 reversed ws in various parts of Y	.26	.22 - .32
7 pauses after reversed ws in various parts of Y	.11	.06 - .13

Here again, the pauses after the reversed ws in Y are significantly longer than the ordinary ones, but the score is not less than unity. Unfortunately, many parts of Y were badly recorded, so that it is not possible to tell why the score is so large; the ws and pauses measured in Y are clearly not a fair sample, but must be pronouncedly shorter than some of those not measured. There is no acceleration in speed in the course of X_2, and there is a significant retardation in X_1. The range of the measurements is often rather large; this may be connected with M's poor motor ability.

Subject N.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = 1.03

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = 1.04).

Part of test concerned	Mean length in inches.	Range of lengths in inches.
10 ws at end of X_1	.20	.18 - .23
10 pauses at end of X_1	.06	.05 - .08
10 ws near beginning of X_2	.215	.20 - .24
10 ws in middle and at end of X_2	.19	.18 - .21
10 pauses near beginning of X_2	.095	.08 - .15
10 pauses in middle and at end of X_2	.07	.06 - .12
10 ordinary ws near beginning of Y	.21	.18 - .24
10 ordinary ws in middle and near end of Y	.19	.18 - .22
10 pauses after ordinary ws at beginning of Y	.08	.06 - .09
10 pauses after ordinary ws in middle and near end of Y	.07	.06 - .08
10 reversed ws at beginning of Y	.22	.19 - .24
10 reversed ws in middle and near end of Y	.20	.17 - .33*
10 pauses after reversed ws at beginning of Y	.07	.06 - .10
10 pauses after reversed ws in middle and near end of Y	.06	.05 - .07

* The second longest measures .21 inches; if the one measuring .33 inches be omitted, the mean length becomes .19 inches.

Subject N's score for the trial done with the pressure pencil is also more than unity. It is a little difficult to tell why this is so, as the differences in length between ws and pauses in the different parts of the test are all extremely slight. The reversed ws show a slight tendency to be longer in Y than in X_2 and the pauses after the ordinary ws in Y tend to be longer than the pauses in X_1, though shorter than those in X_2. Perhaps light would have been thrown on the question if measurements could have been made of the earlier part of X_1. There is a slight tendency towards an acceleration of speed in the course of X_2 and Y , but the differences are not significant.

Subject O.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = .96

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .95).

Part of test concerned	Mean length in inches.	Range of lengths in inches.
6 ws near beginning of X_1	.23	.20 - .24
5 " in middle " "	.23	.21 - .25
7 " near end " "	.23	.21 - .24
5 pauses near beginning of X_1	.06	.06 - .07
6 " in middle " "	.06	.06 - .08
7 " near end " "	.07	.06 - .08
10 ws near beginning of X_2	.28	.25 - .30
4 ws near end " "	.235	.23 - .25
10 pauses near beginning of X_2	.08	.07 - .09
5 " " end " "	.09	.08 - .10
10 ordinary ws near beginning of Y	.22	.19 - .24
" " " at end " "	.21	.20 - .22
10 pauses after ordinary ws at beginning of Y	.07	.06 - .08
10 pauses after ordinary ws at end of Y	.06	.05 - .08
10 reversed ws at beginning of Y	.25	.22 - .28
" " " at end " "	.23	.21 - .25
10 pauses after reversed ws near beginning of Y	.07	.06 - .07
10 pauses after reversed ws at end of Y	.06	.05 - .07

Here the pauses after the reversed ws in Y are exactly the same length, as those after the ordinary ones. The principal cause of the low score seems to be that the ws at the beginning of X_2 were written more slowly, than the ws in any part of Y. Other slight, and not significant, differences between the Y part and the other two parts may have contributed. There appears to have been an acceleration in speed in the course of X_2.

Subject Q.

(Mean $\frac{X_1 + X_2}{Y}$ for trials from the sixteenth to the last = .98.

$\frac{X_1 + X_2}{Y}$ for trial done with pressure pencil = .98).

Part of test concerned	Mean length in inches.	Range of lengths in inches.
10 ws at and near beginning of X_1	.25	.23 - .26
" " at end " "	.24	.22 - .24
10 pauses at and near beginning of X_1	.05	.04 - .07
10 pauses at end of X_1	.05	.04 - .06
10 ws at beginning of X_2	.25	.23 - .26
" " at end " "	.25	.24 - .26
10 pauses at beginning of X_2	.07	.06 - .11
" " at end " "	.07	.06 - .09
10 ordinary ws at beginning of Y	.22	.19 - .24
" " " in middle and at end of Y	.19	.17 - .21
10 pauses after ordinary ws at beginning of Y	.06	.05 - .06
10 pauses after ordinary ws in middle and at end of Y	.04	.04 - .05
10 reversed ws at beginning of Y	.23	.22 - .25
10 reversed ws in middle and at end of Y	.20	.17 - .24
10 pauses after reversed ws at beginning of Y	.06	.05 - .09
10 pauses after reversed ws in middle and at end of Y	.06	.04 - .08

In the case of Subject Q, there is a slight tendency, for the pauses after the reversed ws at the end of Y to be longer, than those after the ordinary ones, but it may not be significant. The reason, why the score is less than unity, appears to be mainly that both sorts of w were written faster at the end of the Y part than in X_1 and X_2. Also the pauses in X_2 are significantly longer, than those after the ordinary ws at the end of Y, while the other pauses in Y are the same length, as those in X_1. There is a significant acceleration, in the course of Y , in the speed of writing both sorts of w .

It is clear that, when the score $\frac{X_1 + X_2}{Y}$ is less than unity, this is not due to any rhythm, which manifests itself in the pauses after the reversed ws in Y being longer, than those after the ordinary ones. The only two subjects, in whose case there is a significant difference of this kind, are L and M, of whom L had a score of less than unity, in the trial concerned, but M one of much more.

As there is a great deal of difference between the performance of different subjects, it is impossible to say for certain, what is the cause of the score/

score $\frac{X_1 + X_2}{Y}$ being sometimes less than unity. A suggestion may, however, be made. It will have been noticed that there is often an acceleration in speed in the X_2 and Y parts. This may be regarded as due to warming up. Since the duration of the Y part is one minute, while that of X_2 is only half a minute, this acceleration is likely to take place proportionately more in Y than in X_2. This, combined with the fact, that there is usually no such acceleration in X_1, is evidently one cause of the score being sometimes less than unity. It thus appears that it is a fault in a perseveration test, if the parts are unequal in length.

In Subjects A, O and Q, the reversed ws are significantly shorter even at the beginning of Y than in X_2, and in Subject Q the ordinary ws are also significantly shorter at the beginning of Y than in X_1. This may possibly be due to a warming-up process which is at work throughout the test, and which, so to speak, lasts across the rest pauses.

CHAPTER VIII. SUMMARY OF CONCLUSIONS AND GENERAL DISCUSSION.

i. Summary of conclusions.

The following conclusions may be regarded as proved:

(1) When the w Test is repeated fifty times the score, in the case of the majority of subjects, continues to vary right up to the last trial, whether the test is scored purely as an alternation test, purely as a creative effort test, or as a combination of the two. While the variability is reduced if the mean score for five successive trials, subsequent to the fifteenth, be taken, even this does not give a wholly reliable score.

(2) The mean score, obtained in the w Test, for any group of five or more trials, subsequent to the fifth, is largely determined by the form of reversed w used by the subject.

(3) The score of an alternation test is not a pure measure of the subject's difficulty in alternating the two kinds of unit, of which the test is composed, unless these two kinds of unit are equal in difficulty, or unless a correction has been made for the effect on the score of their inequality in difficulty.

(4)

(4) An alternation test consisting of "short" units gives a much higher perseveration score, on the average, than one consisting of "long" units. Two tests of the former kind have been found to have a fairly high correlation with each other, but the perseveration score in tests of this type correlates highly with speed in the X part, even although they are scored by the "ratio method".

(5) When a group of normal young adult subjects, who had a cooperative attitude towards the test, were instructed to work as fast as possible, and another such group were instructed to work at their natural pace, the mean speed of the two groups, in the X part of two alternation tests consisting of "long" units, was practically the same. In the w Test, the mean perseveration score was also the same, but in the Division Signs Test, the mean perseveration score was significantly higher for the group who worked as fast as possible. In an alternation test consisting of "short" units, both the mean perseveration score and the mean speed in the X part, were significantly higher, in the group who worked as fast as possible.

(6) The Division Signs Test correlates significantly with intelligence, as measured by the National Intelligence Test, Scale A, Form 2.

(7)/

(7) When the score in the w Test, scored as an alternation test, is less than unity, this cannot be regarded as due to a rhythm, which manifests itself in a relatively long pause after the pairs of ws in the Y part, and thus enables recuperation to take place, and the rest of the Y part to be done relatively faster than the X parts. There is some evidence, that it may be due in part to a warming-up process, which occurs in both the X_2 and the Y part but which has proportionately more effect in the Y part, because it is twice as long as the X_2 part.

ii. General Discussion.

The most important of the above conclusions is the first. If it be assumed, that the true measure of a subject's perseveration is the score, which he obtains after improvement from practice has ceased, then it is impossible to obtain a really reliable score from the w Test, and it is likely that the same would be found true of other motor tests. This would seem to render the value of motor tests very doubtful.

A case can, however, be made out for the view, that the true measure of perseveration is the score made in the first attempt at a motor test. This view has/

has been acted upon by Cattell[5,6,7] and Stephenson[40,41] - though apparently without awareness that their procedure was different from that of Rangachar[31] and Pinard[30] - and has recently been expressed by Cattell[6] with regard to creative effort tests. If, as has been suggested in Chapter V, a subject's perseveration score is determined by the degree of difficulty, which he experiences in performing a new writing movement, it seems reasonable to take as the true score the one obtained when the difficulty is likely to be greatest, that is, the first time the subject does the test. It is also noteworthy that, of the twelve statistically significant correlations between motor tests, that have been obtained by investigators, who either scored the tests by the "ratio method", or eliminated speed in some other way, eight were obtained by Cattell[6], who used the score for the first attempt, and the other four by Wynn-Jones[39] and Hargreaves[16], who appear to have done so, as they say nothing about a practice series.

It thus seems that in future, the score for the first trial at a perseveration test should be regarded as the true one. The reliability of such a test could not be measured, except by making the subject mark what he had done, in each part of the test, when half the time had passed, and thus obtaining a split reliability coefficient, but this would not matter, as the/

the main proof of the value of such a test would be, that it should have high correlations with other similar tests, and with an estimate, or other independant measure, of a temperamental quality or qualities. This state of affairs is far from being reached, but it is possible that the tests might be improved so as to increase their correlations with one another. The tests which appear, from the correlations obtained by Cattell,[6] Hargreaves[16] and Wynn Jones,[39] to be most fully saturated with the quality which motor tests measure, are the Reverse Stroke Test, the S Test, the IT Test and the ∞ ≠ Test. An aspect of the subject, which has probably been too little considered, is that perseveration tests are apparently measuring the initial adaptability, which Snoddy[38] measures by means of mirror-drawing. Wynn Jones[39] found that mirror-drawing correlated .520, .465 and .340 with the Reverse Stroke Test, the IT Test and the S Test respectively. The age and sex differences in perseveration, found by Cattell,[6] are very like the age and sex differences in initial adaptability, found by Snoddy.[38] This further supports the view, that it is really the degree of the subject's difficulty in making a new movement, that is responsible for the correlations between the tests.

It is by the use of scores, obtained from the first attempt at a number of perseveration tests, that/

that one of the most promising attempts has been made to establish a connection between perseveration scores and temperamental qualities. Cattell[7] has recently found that, in a group consisting of his relatives and friends, those with low perseveration scores are more prone to act when dissatisfied with a situation, while those with high scores are more prone to bear unpleasantness, and to do nothing to remove it. The experiment can be criticised, on the ground that Cattell estimated his subjects' temperaments, when he already knew their perseveration score, but the result could be checked, if an investigator first estimated a group of subjects for the qualities in question, and then gave them a number of those perseveration tests, that have been found to have the highest inter-correlations. If they were also given a mirror-drawing test, the identity of perseveration and initial adaptability could be checked at the same time. If some of the tests used were alternation tests, and the scores were corrected for the error,caused by the inequality in difficulty of the two kinds of unit, it would be possible to find, whether pure difficulty in alternating two units is determined by the same factor, as difficulty in performing a new movement.

A number of other suggestions for possible future research have been made in the course of the present work. Many of these have been concerned with the details/

details of motor tests, as,for example, the part played by rhythm in them, and the question whether hindrance is experienced, in passing from one part to another of a relatively complex test unit such as a w or a division sign. Probably such minute problems are not worth investigating, until it has been definitely established that perseveration tests do measure a temperamental quality or qualities. Even then, investigations should be strictly related to the general problem of improving the tests. Here a study of the question, whether it is especially easy to confuse right and left movements, might possibly be of service, for they are involved in some, though not all, of the tests that have proved the most successful.

The fact, that the score in later trials of the w Test is closely related to the form of reversed w used, and the question of the cause or causes of the day to day fluctuations of later trials, are of little importance, if it be assumed that the score obtained at the first trial is the true measure of the subject's perseveration.

An investigation, along the lines already suggested, into the cause of spontaneous imagery might be fruitful. If spontaneous imagery were proved to be due to a need of the mind to work over what it cannot master, this would appear to be a minor form of the repetition compulsion. It is possible that in some/

some individuals the process, whereby a new skill is consolidated in the intervals between practice, might turn out to have a conscious correlate in the form of spontaneous imagery. If it were proved to be due to unconscious motivation, the study of it would connect up with the study of dreams. If it were proved, that both these causes can operate in determining the content of the same image, the question would arise, why occasions, on which the mind is working over unfamiliar material, should be particularly favourable for the expression of a childish interest.

There is no decisive evidence that spontaneous imagery has anything to do with motor tests. If, however, it has, this might be accounted for in two ways. Cattell[7] thinks that individuals with deep conflicts have high scores in motor tests. If spontaneous imagery is due to unconscious motivation, such individuals may have a large amount of spontaneous imagery, because of their conflicts. If, on the other hand, spontaneous imagery is due to a need to work over the unfamiliar, there may be a greater need to do this in individuals with poor initial adaptability. All this is, however, extremely speculative.

The main value of the study of perseveration lies in the fact that it is an attempt to measure temperament and character. The tendency has been to expect that high perseveration would go with introversion,

and/

and low perseveration with extroversion. The results of Cattell's[7] recent investigation provide some evidence that this is so, for a tendency towards decisive action can be roughly identified with extroversion, but the expectation was there before there were any facts to support it. It can be traced to Gross[15],and would seem to be due to a vague, intuitive awareness that introverted individuals repeat behaviour for emotional reasons more than extroverted ones do. A study of the emotional motives for the repetition of behaviour might have considerable value, but would be difficult to make. Certain reasons, why introverted individuals should have a strong tendency to repeat behaviour,can be suggested.They are probably more apt to fear the unknown, and more apt to find situations difficult to master, and therefore to repeat them, by virtue of the repetition compulsion. Perhaps also, like Pavlov's[28] inhibitable dogs, they are less easily bored, and so repeat the same activity for pleasure to a greater extent. Motor tests for perseveration, which are done more or less mechanically, cannot directly measure repetition of behaviour from emotional motives. The only attempt to measure it directly is Cushing's[9] experiment. Even although this experiment cannot give very reliable results, owing to the different meaning, that the same toy must have for different children, it might be worth while to repeat/

repeat it, and to follow up the subjects into adult life, in order to find whether the individual, who as a child of nursery school age, repeats activities longest from interest, is he who turns out in later life to be the most introverted.

It appears, in short, that the study of perseveration has been concerned with three groups of phenomena, which may or may not be connected with one another; the assumption that they are connected has perhaps been made too readily. It has been concerned in the first place with a factor, probably better named initial adaptability than perseveration, to which are apparently due the statistically significant correlations of the first trials at motor tests of perseveration with one another, and with mirror-drawing, and which may be correlated with the temperamental qualities of general decisiveness or indecisiveness of action. In the second place, it has been concerned with spontaneous imagery, which, if Muller's[27] work be excepted, has been studied too superficially, without any attempt to discover its cause, or the conditions of its occurrence. In the third place, it has touched upon the subject of introversion, probably as the result of an awareness on the part of psychologists, that introverted individuals tend to repeat behaviour for emotional reasons.

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